DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE FLIGHT TEST CENTER (AFMC)
EDWARDS AIR FORCE BASE, CALIFORNIA

2 December 1996

Mr. John C. Greenewald
[redacted]

Dear Mr. Greenewald

Thank you, for your letter of 14 November. I'm afraid we do not have any of the documents you requested (including the Appendix to the report I sent you)--nor, in fact, any other documentation pertaining to the contractor test program on the Bell X-5. The Aeronautical Systems Center History Office at Wright-Patterson AFB is the one which is most likely to have documentation of any kind on the X-5 program (though I seriously doubt that they have much on the contractor program; address: ASC/HO, 2275 D Street, Suite 2, Wright-Patterson AFB, OH 45433-7219--Chief Historian is Ms. Diana Cornelisse). The Technical Library at Aeronautical Systems Center is another possibility that comes to mind (don't have a number or address but the ASC/HO folks should be able to provide). Also, I recently discovered that Special Collections and Archives Department of Wright State University, also in Dayton, has a major aviation collection. Don't know the contents but it might be worth a try. Finally, you may want to call Jay Miller. He got into the Bell Archives before they were dispersed and he managed to collect a *lot* of documentation. The most recent number I have for him is [redacted]

As I indicated, our archives primarily focus on Air Force involvement in these programs and this is certainly true with regard to the second-generation X-1 aircraft. I've enclosed a couple of reports on testing (but even the X-1A report, as you'll see, focuses on AF flights). The X-1E was solely a Bell-NACA program. I'm also sorry to say that we apparently do not have anything on the Rascal program.

Best of luck with your search.

Sincerely

JAMES O. YOUNG, PhD
Chief Historian

[redacted]

[redacted]

BELL Aircraft CORPORATION

BUFFALO 5, NEW YORK

TECHNICAL DATA

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BY . . . J. L. Zwilt . . . . . DATE . July 23, 1952

CHECKED . . . D. E. Shirlaw . . . DATE . July 23, 1952

APPROVED . W. M. Smith . . . DATE . 23 JULY 1952

APPROVED . [illegible] . . . . . DATE . 24 July 1952

APPROVED . L. K. Tate . . . . . DATE . 24 July 1952

APPROVED . [illegible] . . . . . DATE . 24 July 1952

CONTRACT NO. W33-038 Ac20062 NO. OF PAGES 5

REPORT NO. 58-947-010 MODEL X-1A
X-1B

FLIGHT TEST, RESEARCH AIRPLANE

ROCKET PROPELLED, HIGH SPEED

COPY NO: 9 ISSUE DATE: July 15, 1952

REVISIONS

DATE	PAGE NO.
Rev. 1 10-22-52	Page 4 and 5 revised in accordance with Paragraphs b and c of WADC letter WCOWF/JBT/evm dated 19 September 1952

[redacted]

[redacted] SECURITY INFORMATION

CLASSIFICATION CHANGED TO Unclassified

by Authority of WADC TWX WCIPP-10-25-M dtd 29 Oct 58, by

Samuel Hamill 7 Nov 58.

FORM E9-1 NO. 195-L REVISION "A"

[redacted]

FLIGHT TEST, RESEARCH AIRPLANE

ROCKET PROPELLED, HIGH SPEED

SPECIFICATION FOR

1.0 SCOPE AND CLASSIFICATION.

1.1 Scope: This specification outlines the requirements of Bell Aircraft Corporation for the demonstration and testing of the airplane defined in Bell Aircraft Corporation Specification 58-947-001. The requirements shall be used to qualitatively demonstrate flying characteristics comparable to X-1 Series Airplanes, operational reliability of the power plant and other airplane systems, and the structural integrity of the airplane. This specification shall apply in its entirety to either the X-1A or the X-1B, depending on which airplane is first available for flight test. The remaining airplane will require only those functional flight checks by the contractor deemed necessary to demonstrate airworthiness.

2.0 APPLICABLE SPECIFICATIONS.

2.1 Contractor Specifications: Bell Aircraft Corporation Model Specification 58-947-001, dated 5 May 1948, including Revision 2, dated 21 April 1951.

3.0 REQUIREMENTS.

3.1 General: The tests shall be conducted by Bell Aircraft Corporation personnel. The detailed flight outline presented in Appendix I is intended to be used as a basic approach to enable the contractor to demonstrate the requirements set forth in this specification and may be deviated from as necessary in the interest of safety, economy and/or convenience. Both airplanes may be used to meet requirements set forth in this specification.

3.2 Approval of Requirements: The requirements herein specified shall be subject to approval by the Procuring Agency.

3.3 Changes: Changes to these requirements shall be submitted to the Procuring Agency for approval.

[redacted]

[redacted]

3.4 Deviations: The requirements herein specified deviate from the requirements of the following:

3.4.1 Bell Aircraft Corporation Model Specification 58-947-001, dated 5 May 1948, including Revision 2, dated 21 April 1951. Paragraph E.3 c. shall not be applicable.

3.5 Tests: The test program shall consist of captive and free (glide and power) flights deemed necessary to comply with demonstration requirements.

3.5.1 Captive Flights: These flights shall be conducted with the rocket airplane attached to the carrier airplane launching gear.

3.5.1.1 Preflight Familiarization: The pilot and other personnel shall familiarize themselves with pilot loading, check lists, timing, equipment checkout and other operational techniques.

3.5.1.2 Functional Tests Before Powered Flights: Cabin pressurization, in-flight jettison checks, liquid oxygen top-off and such other tests as are deemed necessary to establish safe operational procedures shall be conducted in flight.

3.5.2 Free Flights: Flights will be made to demonstrate the following:

3.5.2.1 Launching: Safe launching of this aircraft from the carrier airplane.

3.5.2.2 Stability and Control: Stability and control, qualitatively similar to that of Bell Model 44 X-1 airplane, shall be demonstrated up to 0.8 Mach Number and will be substantiated by reports of contractors test pilots' observations.

3.5.2.3 Structural Integrity: Maximum acceleration obtainable not to exceed .6 (n-1) +1 (where n is the positive limit load factor), which results in a load factor of 4.8g, or excessive buffeting at the design gross weight for stress analysis between 15,000 and 20,000 feet P.A. at 0.8 Mach Number. Every attempt shall be made to combine the structural integrity demonstration with the power plant tests.

Reference: Paragraph F-1, C-1803-E (R-1803-11), Structural Integrity Flight Demonstration Requirements for Airplanes.

3.5.2.4 Power Plant Reliability: Powered flights shall be made to demonstrate the reliability of the power plant system. Refer Appendix I.

[redacted]

4.0 NOTES.

This specification, when approved, shall govern the Flight Test Program of the articles as delivered.

1 Rev. 1

APPENDIX I

POWER PLANT RELIABILITY

The purpose of this Appendix is to set forth a tentative Power Plant Reliability Test Program which shall serve as a thorough operational and functional check of the power plant installation.

Successful captive, glide and power flights shall be made to demonstrate the reliability of the power plant system. Each phase shall be successfully completed before proceeding to the next phase.

Phase I Captive Flights

Tests to develop proper procedures and methods for pre-launch operations and captive in-flight propellant jettisoning.

Phase II Glide Flights

Free flights shall be made without operating the power plant to demonstrate satisfactory operation of the airplane and its systems. A minimum of one successful drop with full propellant load shall be made to establish under actual conditions timing and procedures for propellant jettisoning.

Phase III Powered Flights

During the powered flight phase, the following power plant tests shall be made in the sequence indicated. Tests A, B and C shall be successfully completed twice before proceeding to the next operation. During the duplicate power plant tests, additional stability, control and structural checks shall be made.

A. Drop airplane fully loaded at launch altitude.
Fire #1 thrust chamber - run 30 sec. - turn #1 off
Fire #2 thrust chamber - run 30 sec. - turn #2 off
Fire #3 thrust chamber - run 30 sec. - turn #3 off
Fire #4 thrust chamber - run 30 sec. - turn #4 off
Jettison remaining propellants and land. 7

B. Drop airplane fully loaded at launch altitude.
Fire #1 - #2 T.C. - run 30 sec. - turn #1 - #2 off
Fire #3 - #4 T.C. - run 30 sec. - turn #3 - #4 off 4
Jettison remaining propellants - land.

C. Drop airplane fully loaded at launch altitude.
Fire #1 - #2 - #3 T.C. - run 30 sec. - turn #1 - #2 - #3 off
Fire #1 - #2 - #3 - #4 T.C. - run 10 sec. - turn #1 - #2 - #3 - #4 off 6
Jettison remaining propellants - land.

1 Rev. 1

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D. Drop airplane fully loaded at launch altitude.
Fire #1 - #3 T.C. - push over from climb attitude until negative "G" (not exceeding one) causes power plant to malfunction. Turn T.C. off. Jettison remaining propellants - land. This phase will not be completed until the engine manufacturer's written approval is obtained.

E. Drop airplane fully loaded at launch altitude.
Fire #1 T.C. - run 15 sec. turn #1 off
Fire #1 - #2 T.C. - run 15 sec. - turn #1 - #2 off
Fire #1 - #2 - #3 T.C. - run 15 sec. - turn #1 - #2 - #3 off
Fire #1 - #2 - #3 - #4 T.C. - run 10 sec. push over from climb attitude until power plant malfunctions - turn #1 - #2 - #3 - #4 off. Jettison remaining propellants - land.

F. Drop airplane fully loaded from launch altitude. Fire #1 T.C. - run for full duration until power plant malfunctions. Turn T.C. off. Jettison remaining propellants - land.

Caution must be exercised to insure that the airplane flight demonstrations conducted during these flights do not call for flight plans requiring maneuvers that have not been previously proven satisfactory with power plant operating. (Example: Acceleration less than +1g should not be flown, with rocket running, before Test D is conducted)

Incorporation of changes to eliminate deficiencies in the power plant may require recheck of previously acceptable tests.

[redacted]

[redacted] INFORMATION [redacted]

X-1

7-1 X-1 #3

FLIGHT TEST PROGRESS REPORT NO. 15

Period From 9 December Through 20 December 1953

X-1A AIRPLANE

CONTRACT W33-038-ac-20062

CLASSIFICATION CHANGED TO Unclass
By Authority of WAPC TWX WEIPP 10-25-M dtd 29 Oct 58, by
L. Hamill 7 Nov 58.

BELL Aircraft CORPORATION

[redacted]

54-2241

3 FEBRUARY 1954

REPORT NO. 58-980-019

FLIGHT TEST PROGRESS REPORT NO. 15

Period From 9 December Through 20 December 1953

X-1A AIRPLANE

CONTRACT. W33-038-ac-20062

BELL Aircraft CORPORATION

[redacted] INFORMATION [redacted]

X-1A FLIGHT TEST PROGRESS REPORT

PREPARED BY: J. L. Powell, Jr.
J. L. Powell, Jr.
Flight Test Engineer

APPROVED BY: S. R. Sartore
S. R. Sartore
Field Test Manager

APPROVED BY: Joseph A. Cannon
Joseph A. Cannon
Chief of Flight Test

BELL Aircraft CORPORATION

[redacted]

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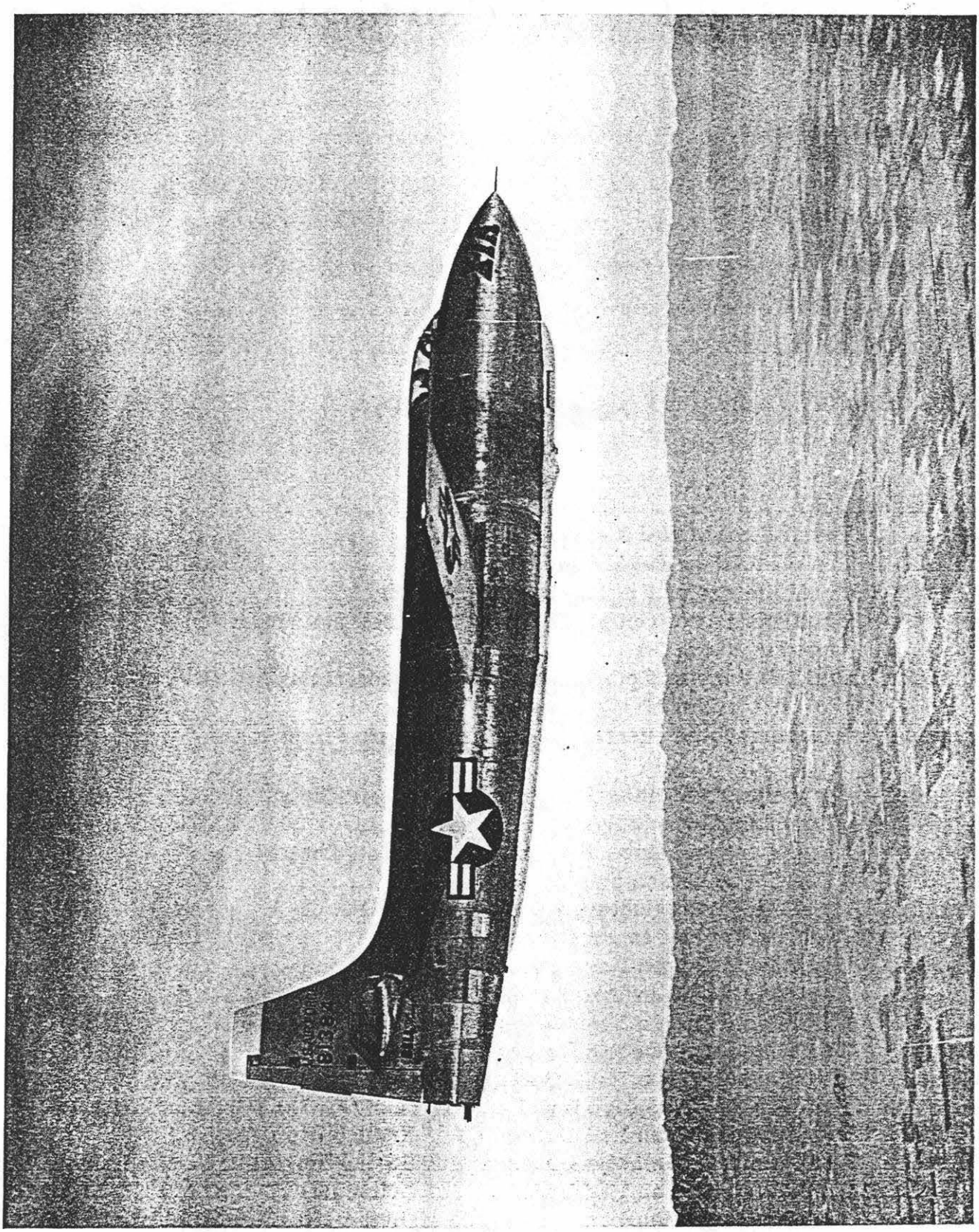


I Introduction

This is the fifteenth of a series of progress reports prepared to give the U.S.A.F. an organized technical survey of the flight tests and activities on the X-1A Airplane. This report summarizes the activities for the one and one-half week period from 9 December through 20 December 1953.

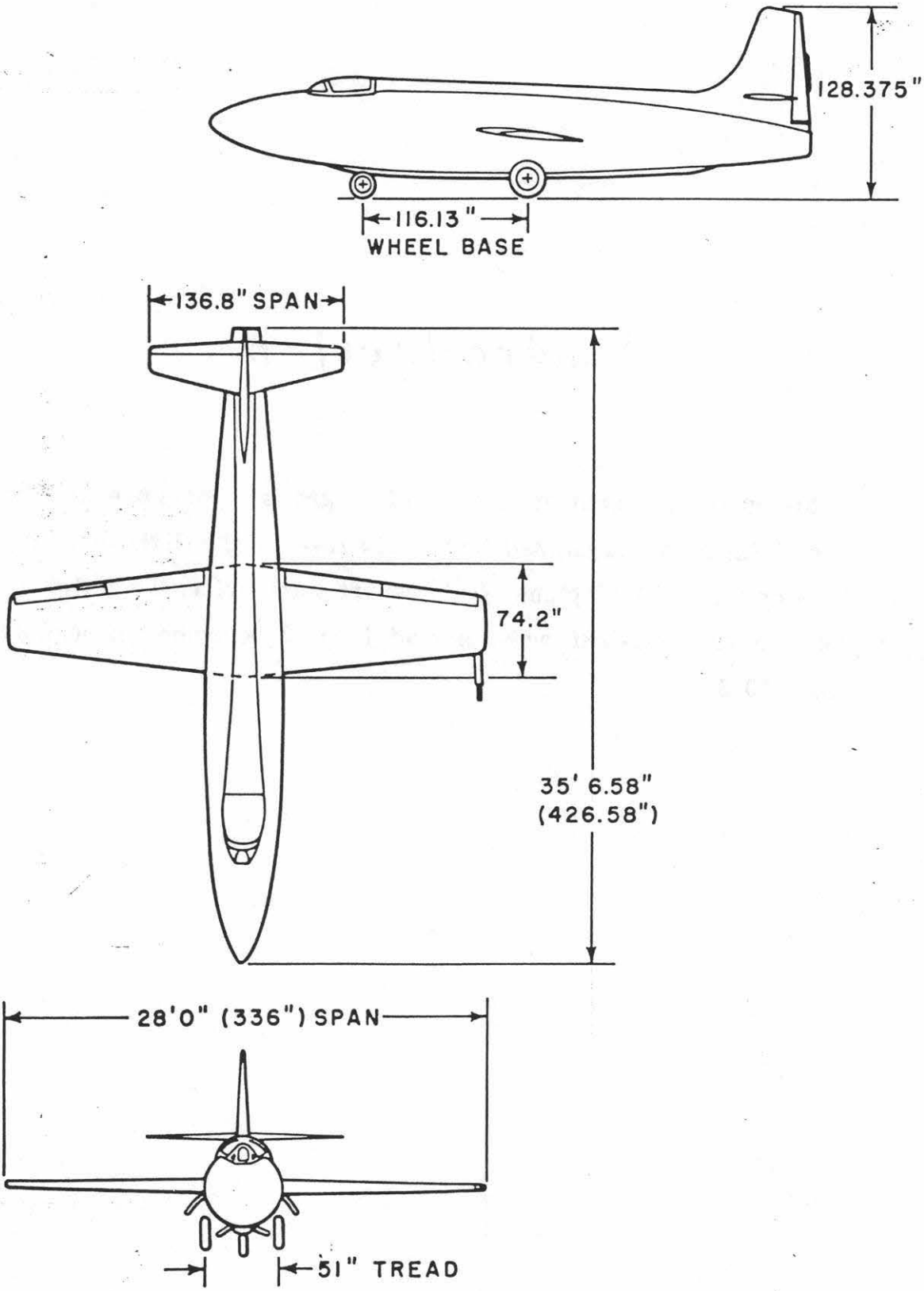


Figure 1. Three View of X-1A Airplane

II Summary

Flight No. 1384-10 was successfully completed on 12 December 1953. The rocket engine power plant operated on all four chambers successfully. No malfunctions of any kind developed.

Climbing speeds and paths used in this flight were predicated on data procured on the previous two flights. The pilot on this flight was Major C. E. Yeager. An indicated Mach number of 2.535 was attained in a slight dive at an altitude of 74,700 feet. This information is from the X-1A photo panel. The flight and handling qualities of the X-1A Airplane were normal until power plant shutdown. At this time the X-1A Airplane became unstable and entered into right and left rolls which could not be controlled by the pilot. The first maneuver recognized by the pilot was an inverted spin at 33,000 feet. The X-1A Airplane then went into a normal spin and a recovery was made at 25,000 feet. A normal let down and landing were made.

The postflight inspection revealed no damage to the X-1A Airplane except cracked inner canopy glass, a nonstructural failure caused by the helmet of the pilot's pressure suit striking the glass.

III Activities

The following changes were made on the X-1A Airplane after Flight No. 9 and prior to Flight No. 10:

1. Installed type A-3 Machmeters in pilot's panel and photo panel. (Figure 2 herein and also Figure 3 of Bell Aircraft Report No. 58-980-018.)
2. Replaced the fuel tank relief valve.
3. Replaced the rate of pitch gyro.
4. Replaced NACA radar synchronizer recorder.
5. Installed NACA inverter for recording instrumentation. (Figure 6 of Bell Aircraft Report No. 58-980-018.)
6. Installed pressure suit mask heater control and wiring.
7. Moved breathing oxygen hose to left side of cockpit to comply with pressure suit arrangement.
8. Removed 10 pounds ballast from hose, 40 pounds remaining.
9. Replaced flexible igniter fuel lines with stainless steel lines on R.M.I. rocket engine.
10. Added copper and asbestos flame shield around engine exhaust of thrust chambers. (Figure 7.)
11. Weight and balance was calculated and adjusted to 16,199 pounds and 22.56 percent MAC for launch condition.
12. Inflight lox top-off procedure was modified to prevent loss of lox prior to launch.
13. An impromptu heat survey was initiated by using Tempilac paint at several critical points on the X-1A Airplane. (Figures 10, 11, 12, and 13.)
14. NACA recording instrumentation was checked and calibrated by NACA personnel prior to flight.

15. The leading edges of the nose, wings, stabilizer, and rudder were smoothed and filled with aerodynamic filler.

16. An igniter check was made on the rocket engine.

The Mother Aircraft, B-29 Serial No. 45-21800, was pressure checked and loaded with liquid oxygen for leak checks.

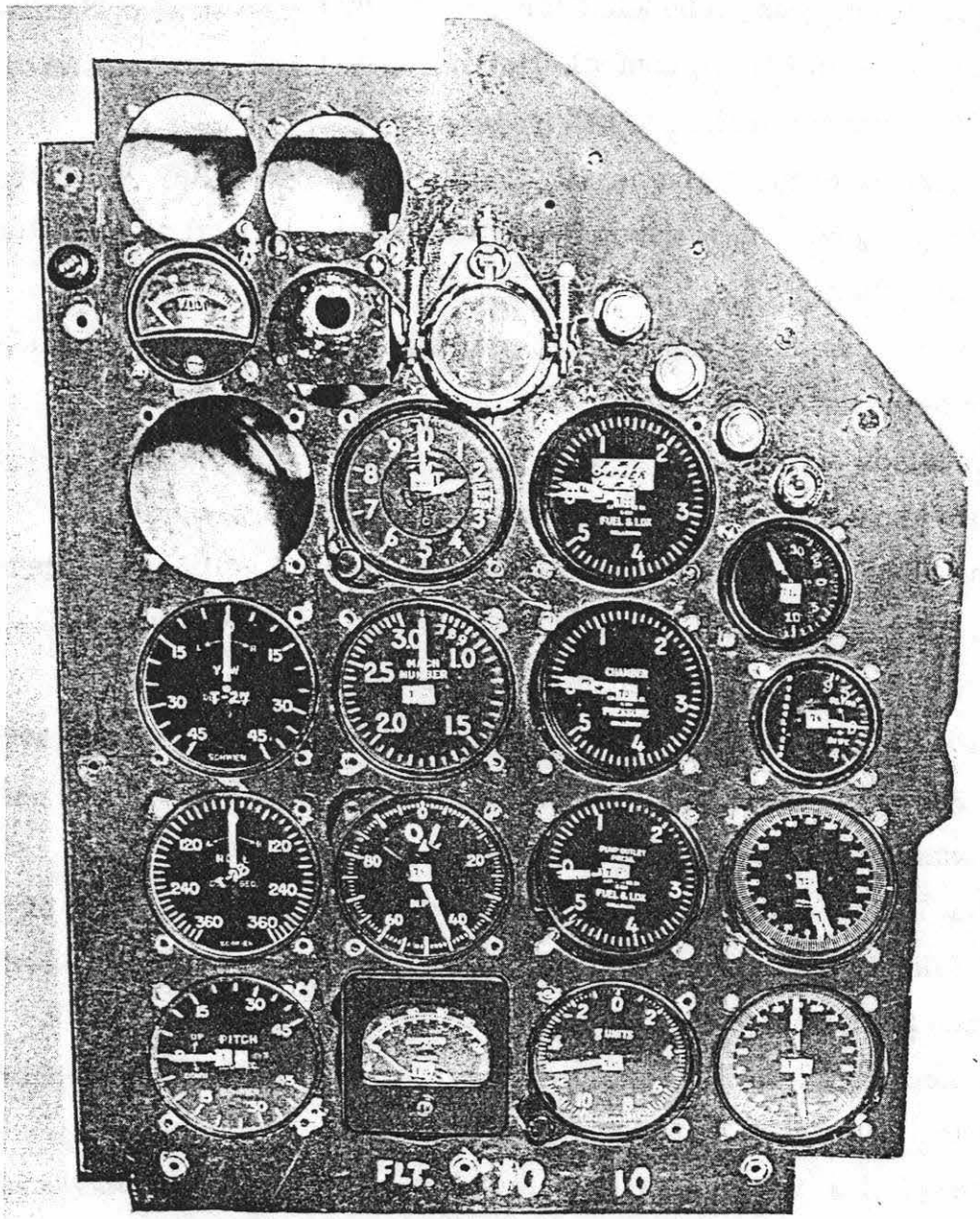


Figure 2. Photo Panel in X-1A Airplane

IV Results

Flight 1384-10 of the X-1A Airplane was successfully accomplished on 12 December 1953.

This flight was scheduled for power plant operation, optimum climb path determination, control effectiveness at high Mach numbers, and NACA radar calibration of the airspeed system.

A normal drop was made at 31,000 feet with no delay occurring on the drop signal. The pilot noticed no directional oscillations after drop on this flight.

Power plant operation was completely satisfactory with no malfunctions occurring during flight.

Scheduled climb paths and speeds were held closely to the programmed speeds and altitude as set up in the flight plan.

The elevator was used effectively throughout the climb and pushover for pitch control. The stabilizer remained in neutral position. Aileron effectiveness increased at the higher Mach numbers.

An indicated Mach number of 2.535 was attained during this flight. The peak altitude attained was 76,700 feet. The peak Mach number was attained at 74,700 feet (Figures 3, 4, and 5e).

The NACA radar synchronizer recorder timing trace was extremely faint on the record film. It is doubtful whether the airspeed system can be calibrated from this flight.

Immediately after engine shutdown, the X-1A Airplane became unstable and entered rolls to the right and left.

The pilot's face mask heater of his pressurized suit operated satisfactorily but the face piece became slightly fogged during short periods of high physical activity.

A normal let down and landing was made after recovering control at approximately 25,000 feet.

The Tempilac paint disclosed aerodynamic heating up to a 233° F rise. Adjacent internal structure to the Tempilac paint caused skips in the temperature indication.

The operation of the copper flame shield was entirely satisfactory with only slight buckling occurring at the high temperature points. Tempilac paint of 2,000° F range around the thrust chambers was completely burned away showing that temperatures in excess of 2,070° F (ambient temperature plus rise) were encountered during this flight (Figure 6). A photograph (Figure 7) of the flame shield before the flight is included for comparison purposes.

The postflight inspection revealed that both rate of pitch and rate of yaw indicators had been damaged during the flight.

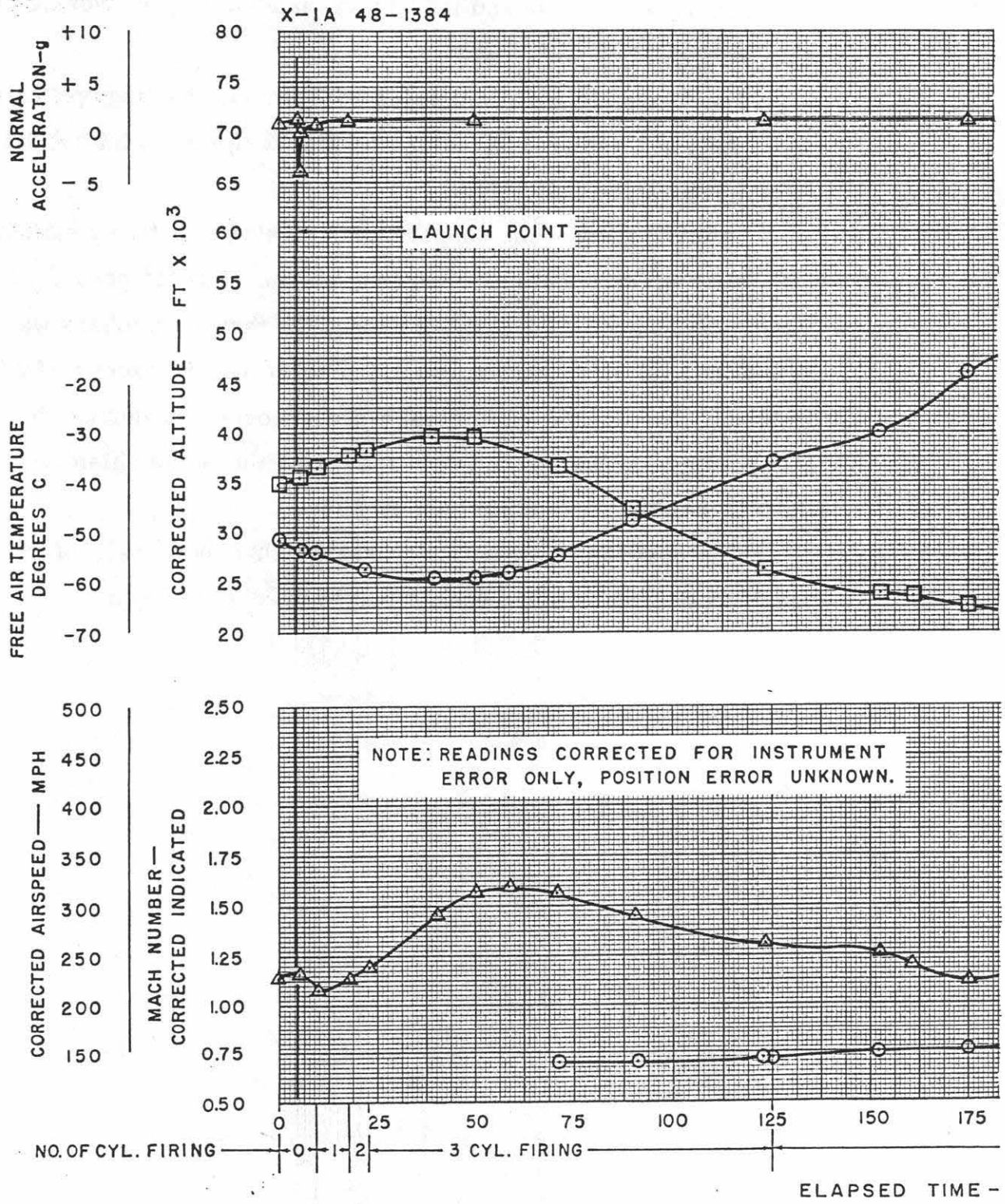
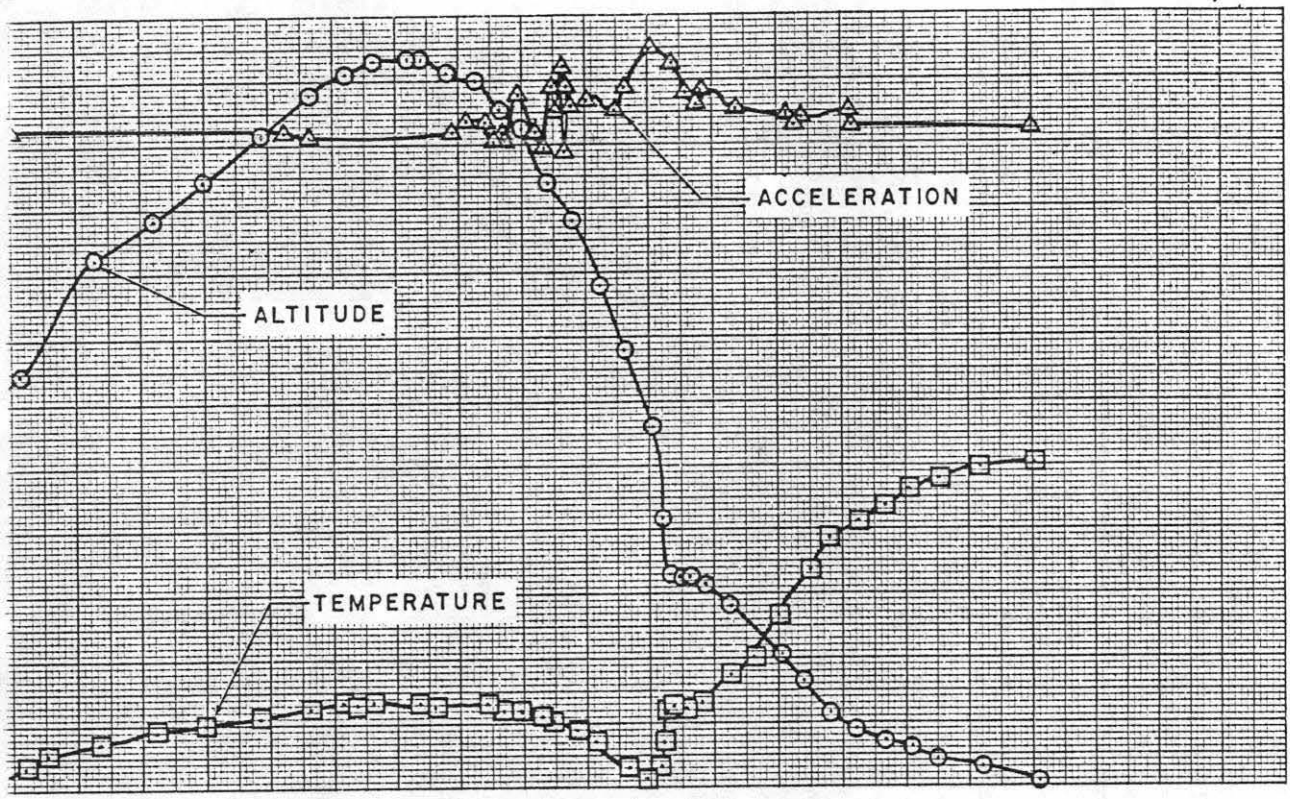
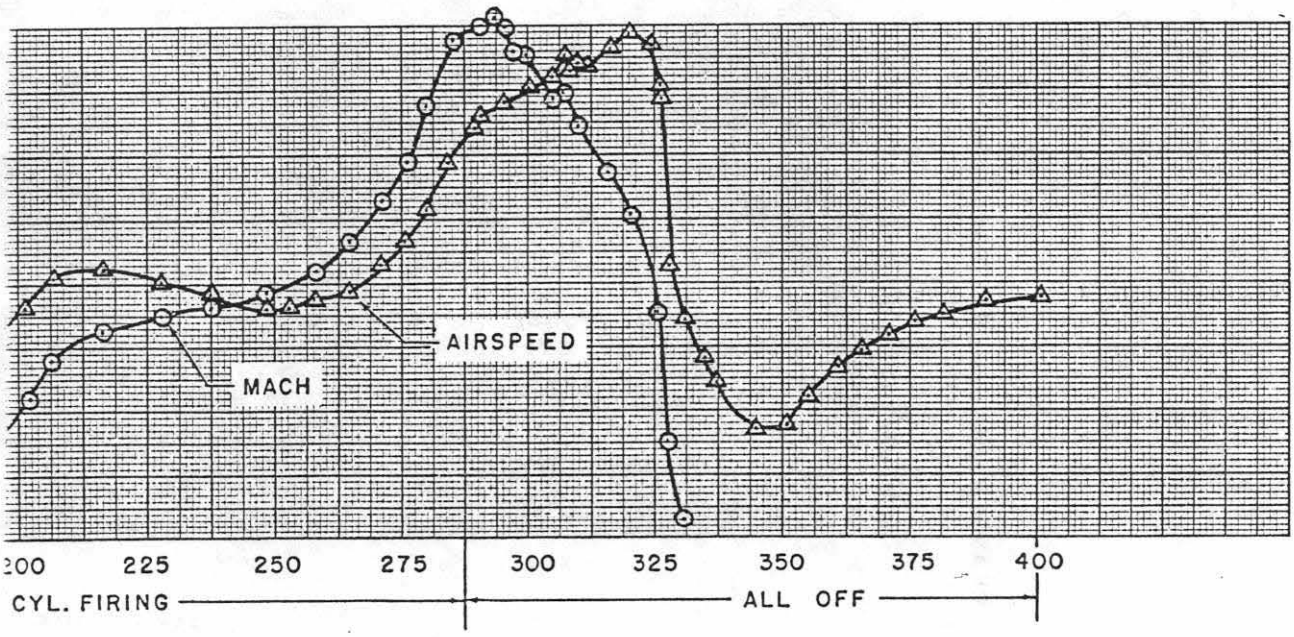


Figure 3. Time History o

DECEMBER 12, 1953





ight Path for Flight No. 10

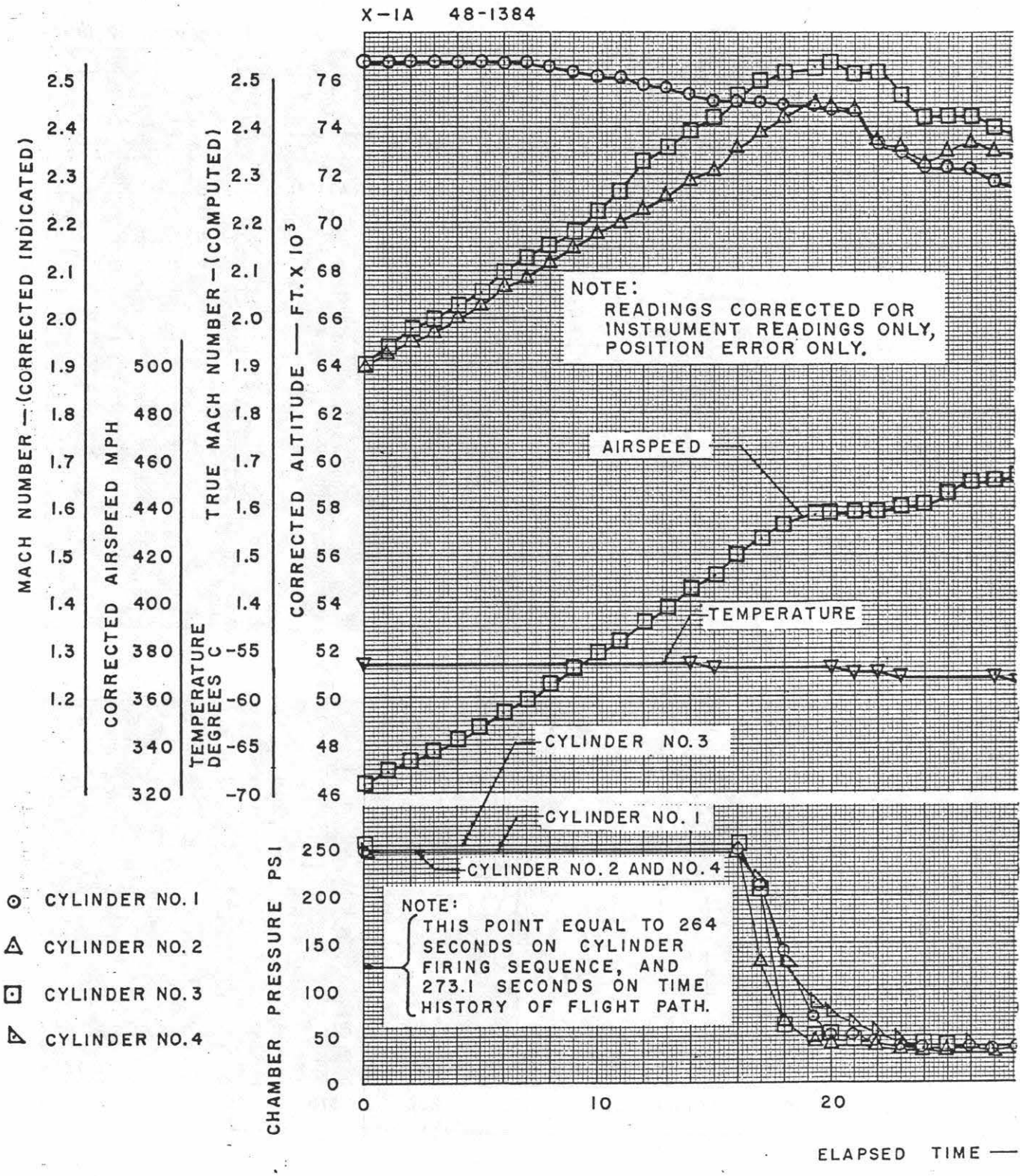


Figure 4a. Time History of Optimum

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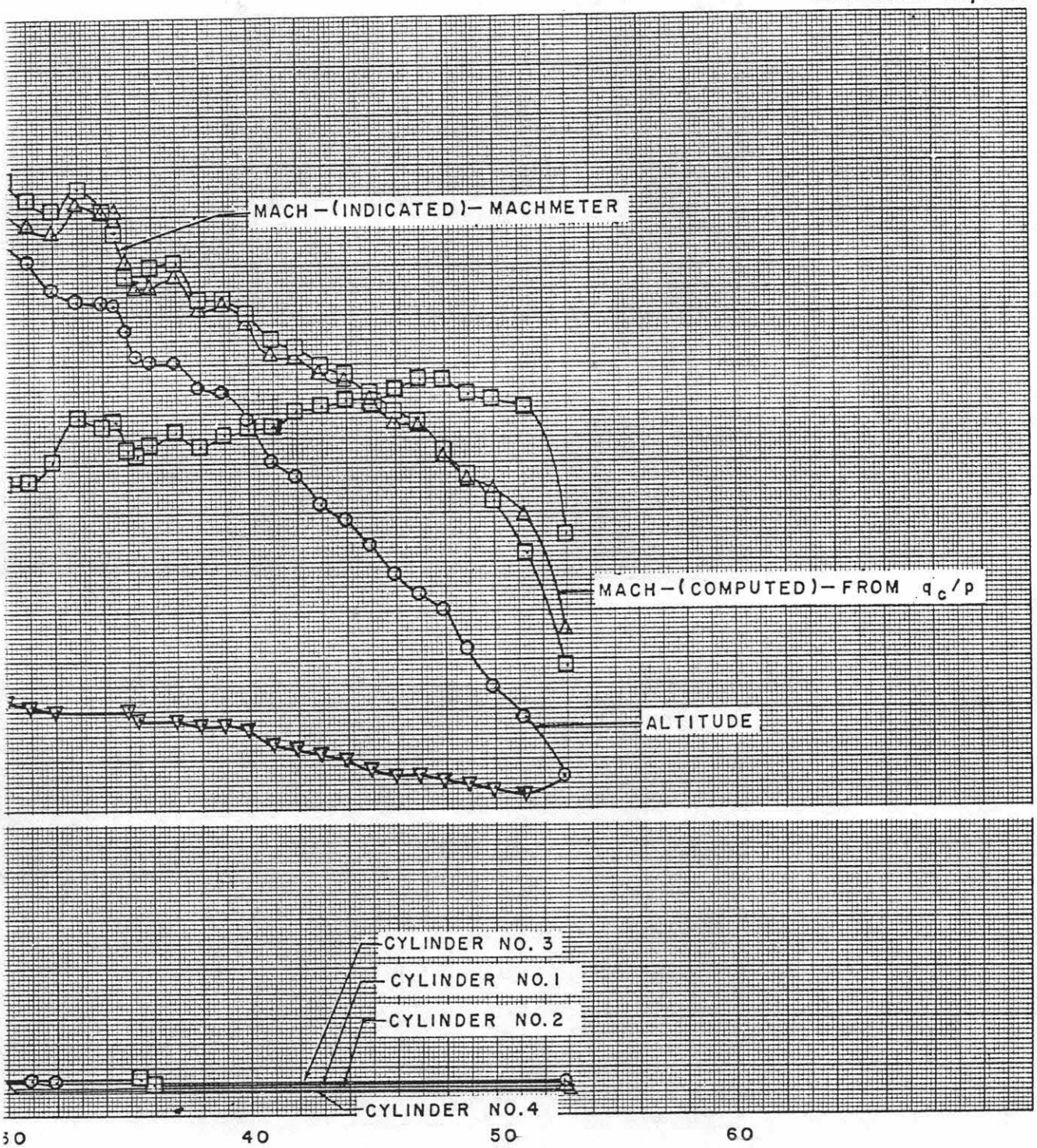

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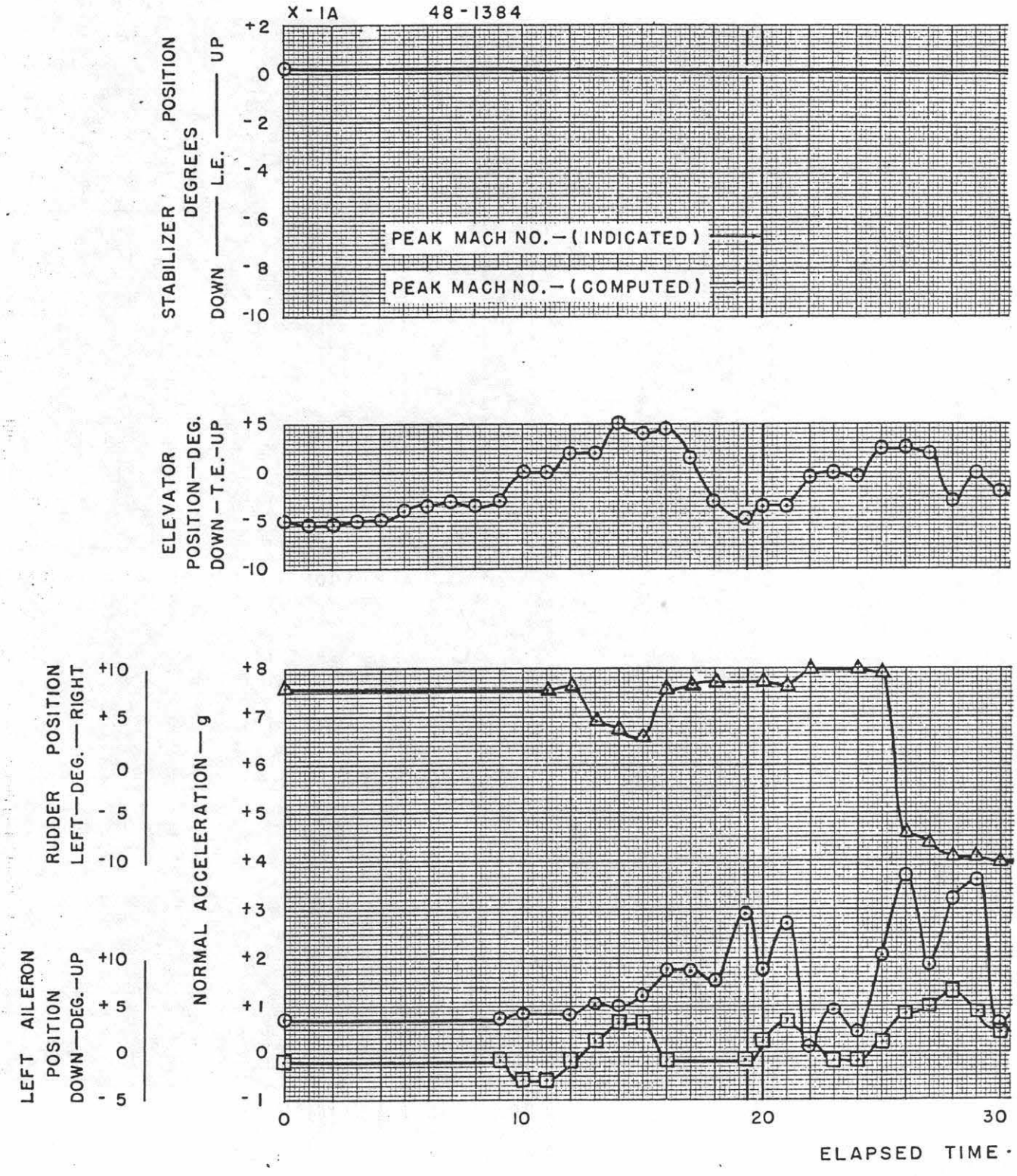
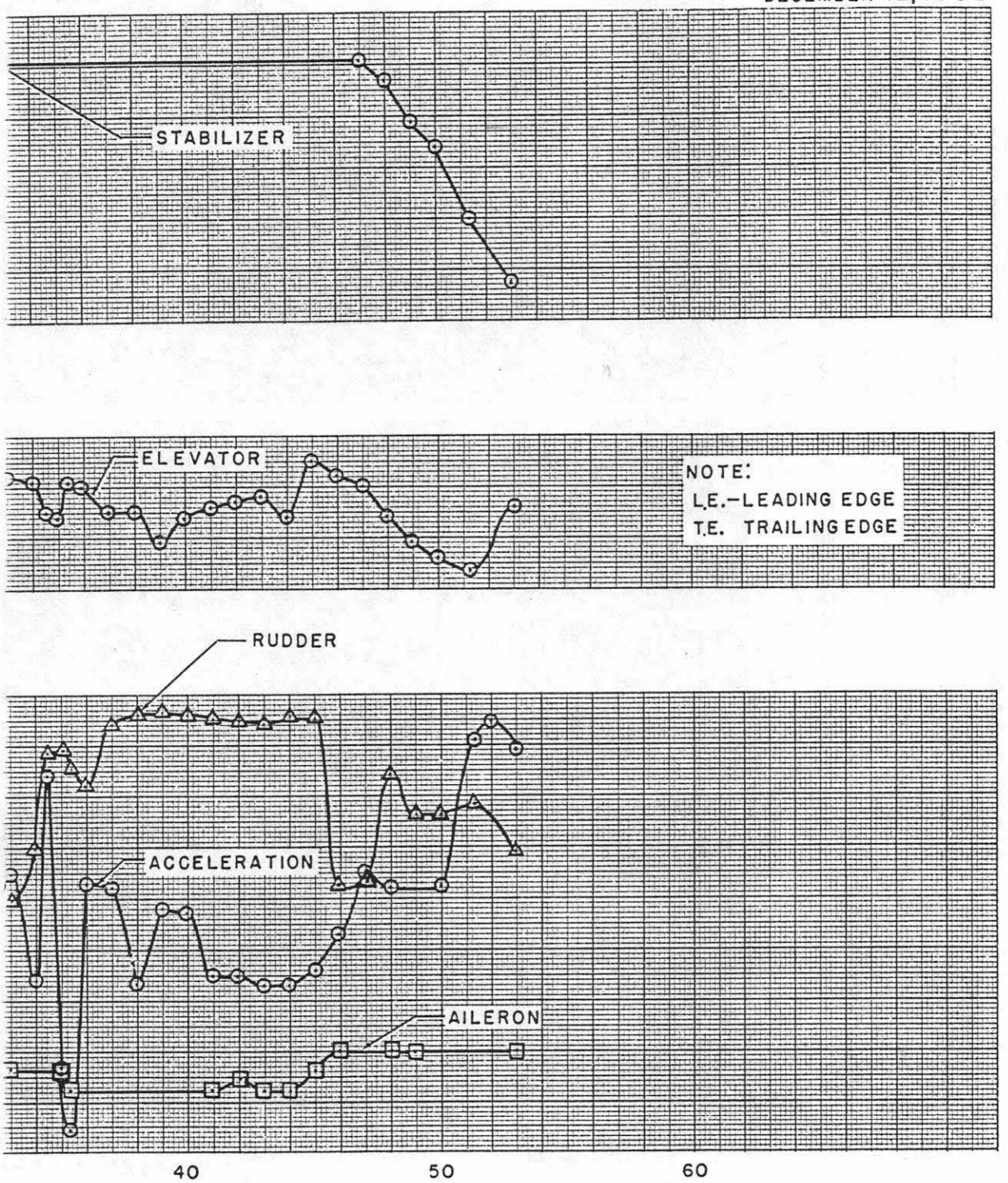


Figure 4b. Time History of Optimun

DECEMBER 12, 1953



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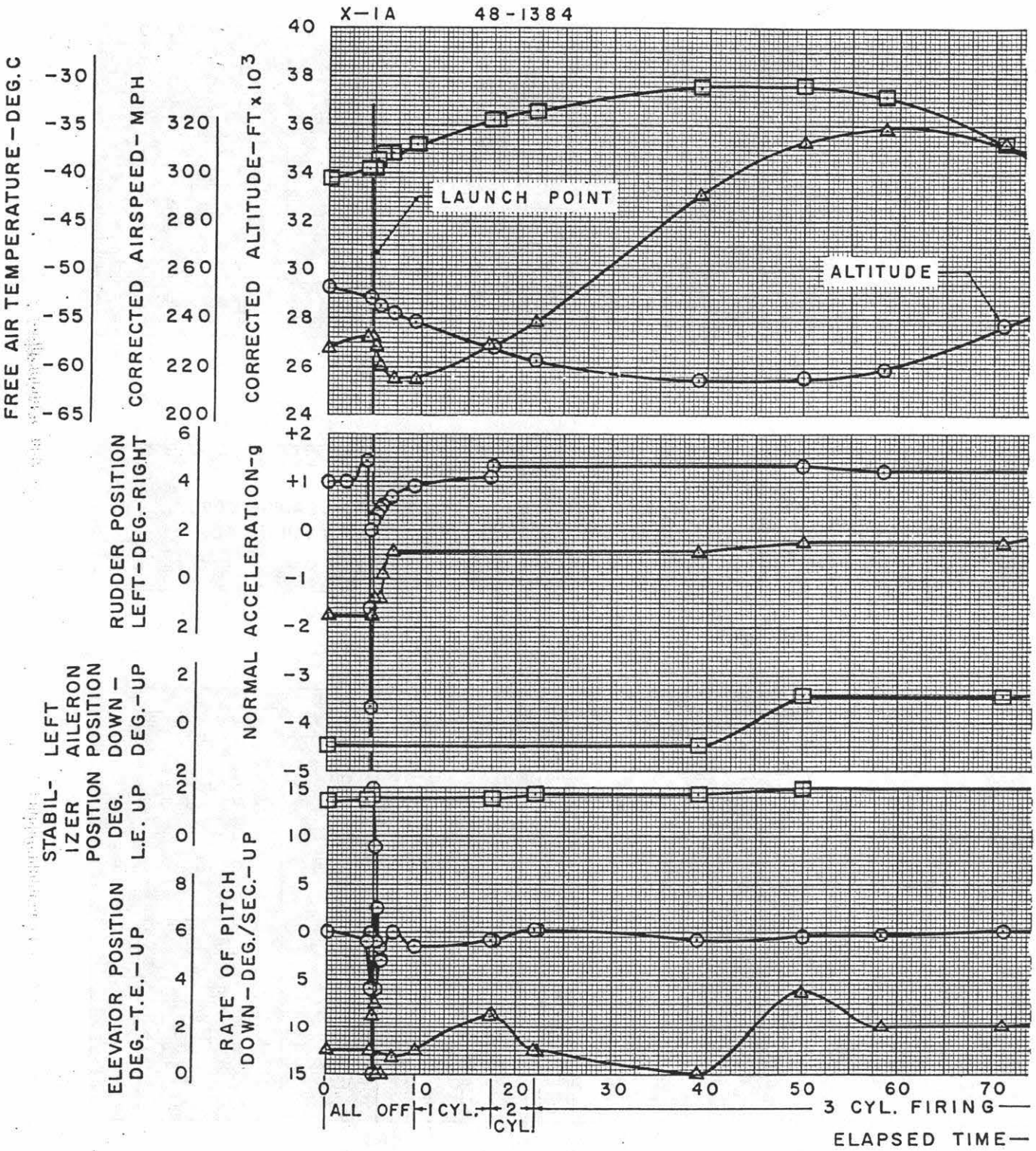

Figure 5a. Expanded Time History

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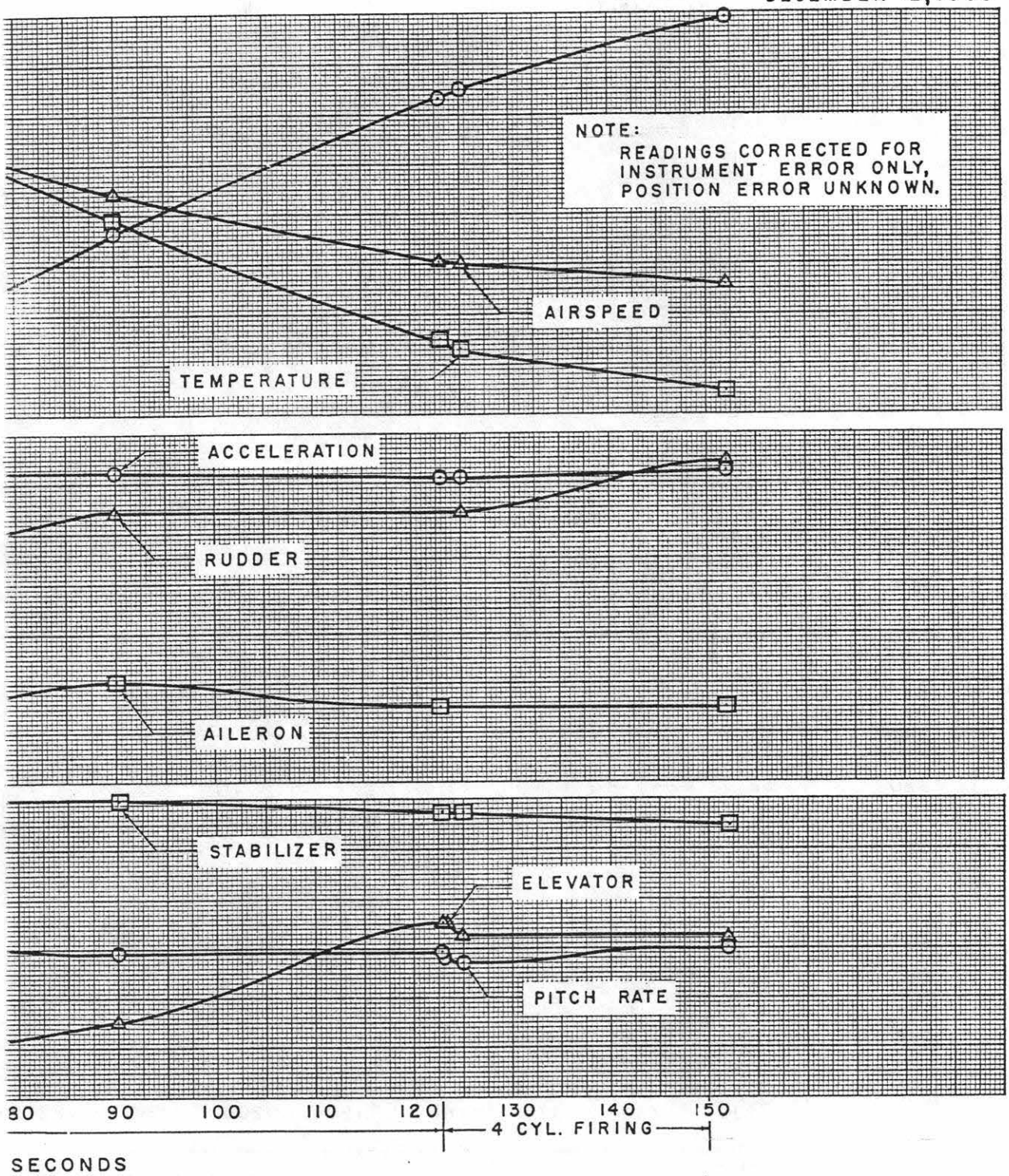

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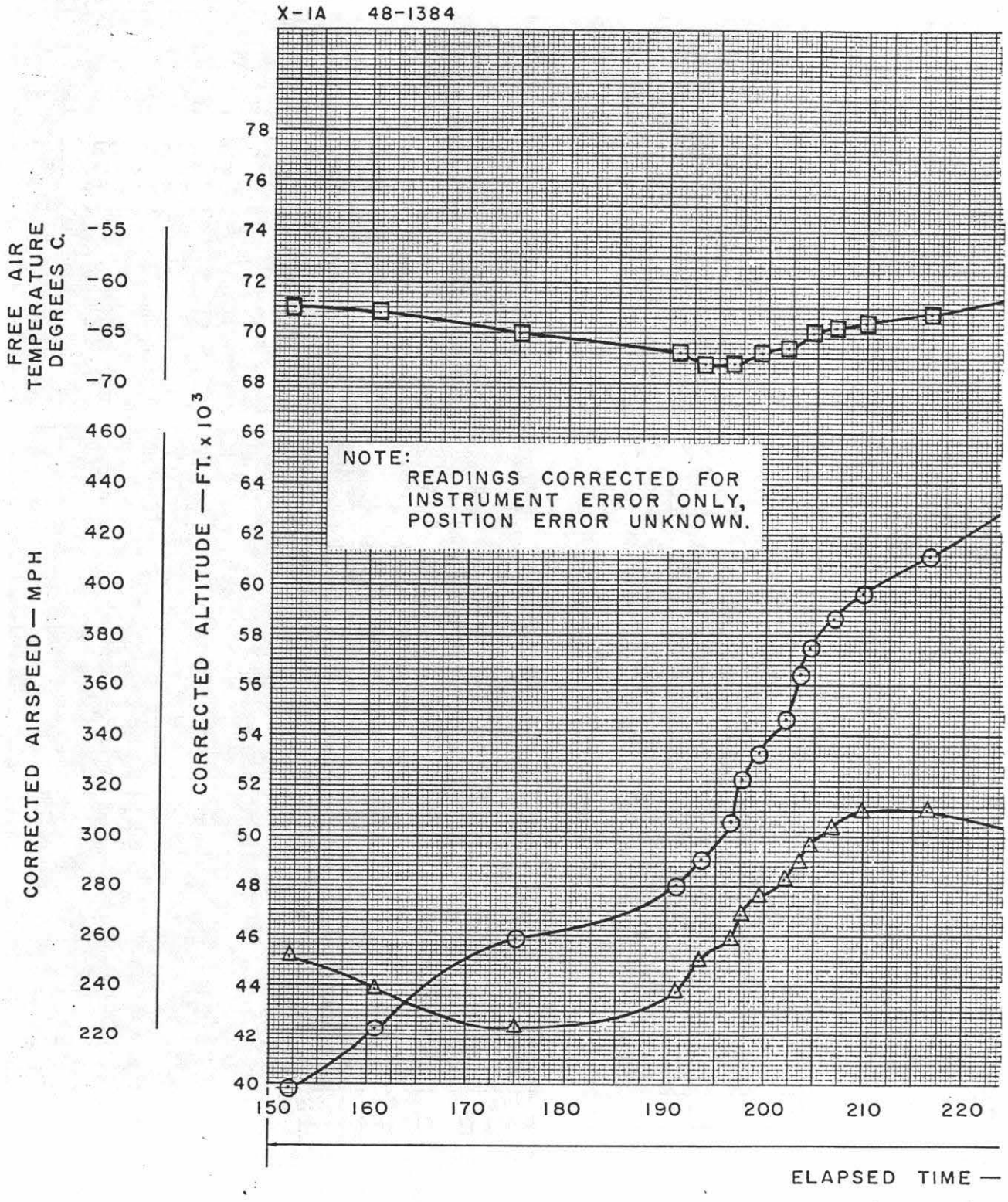

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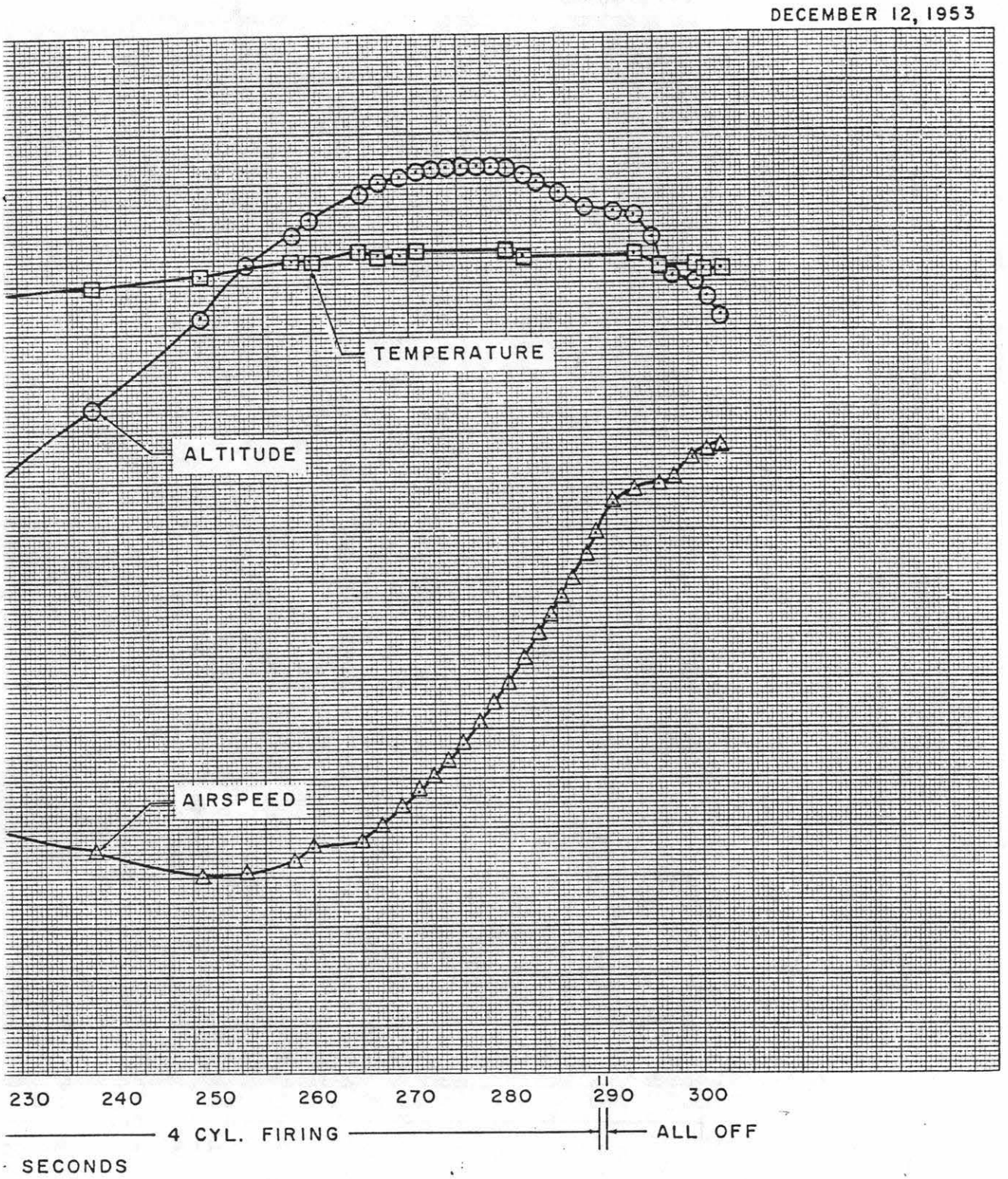

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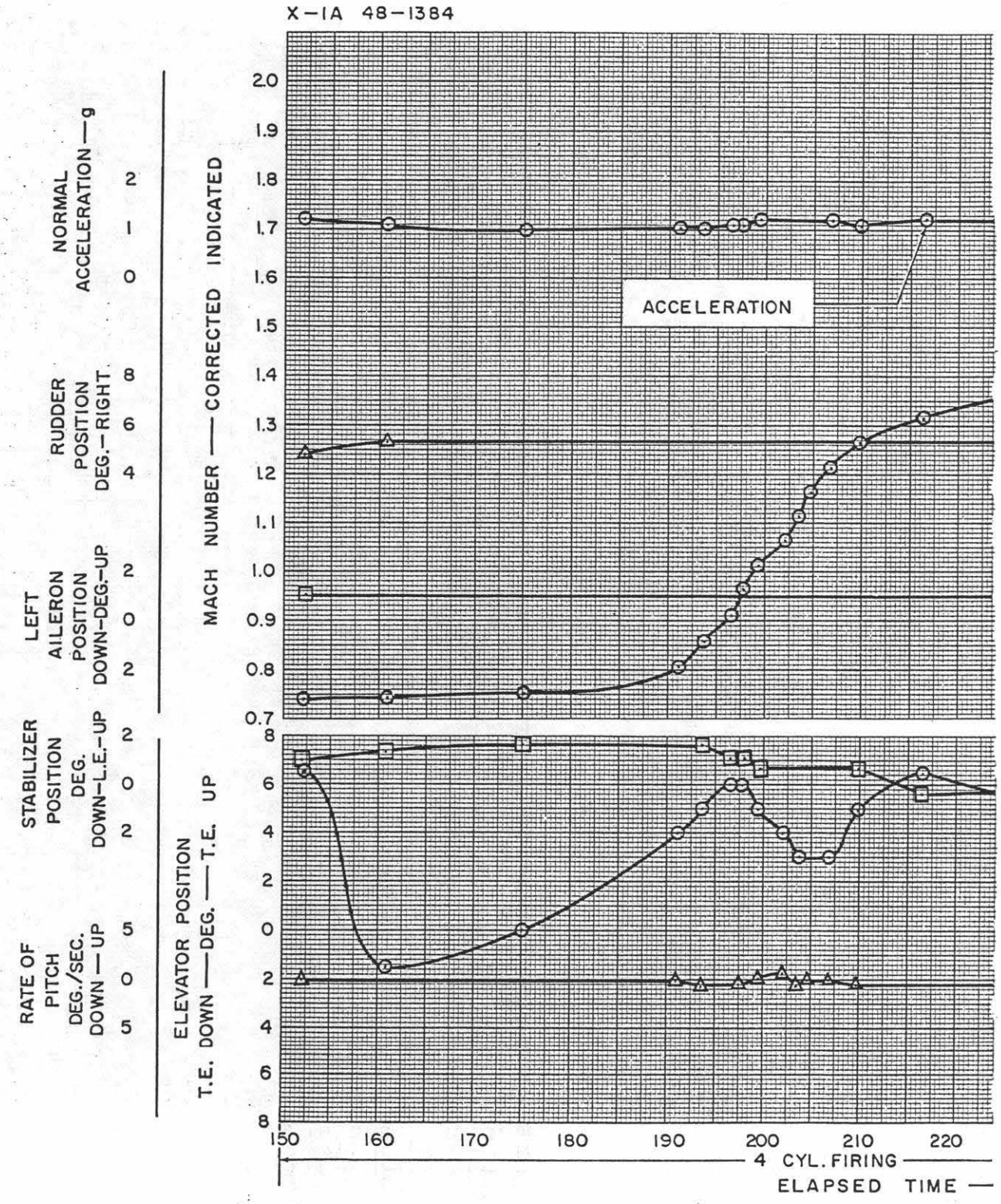

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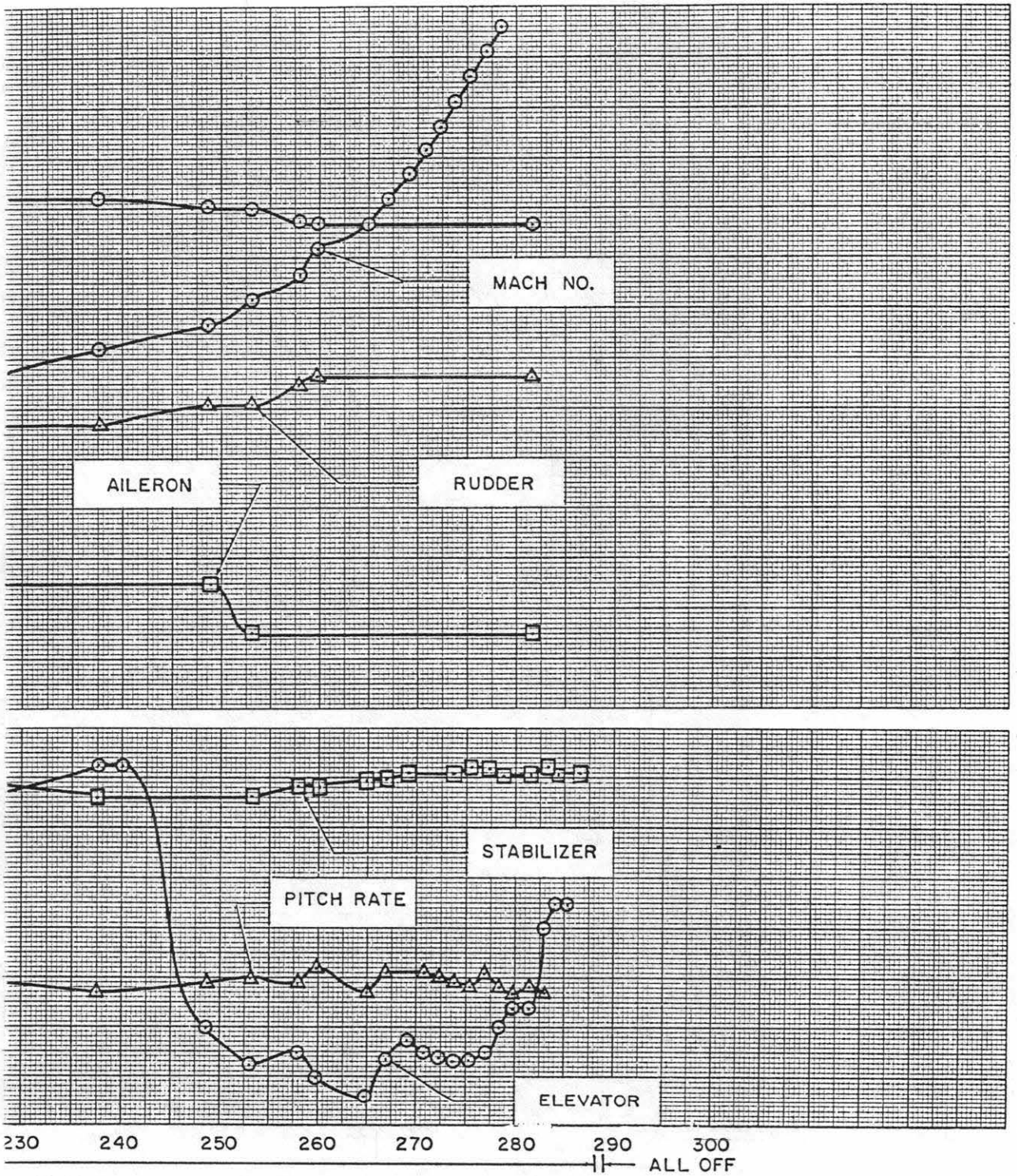

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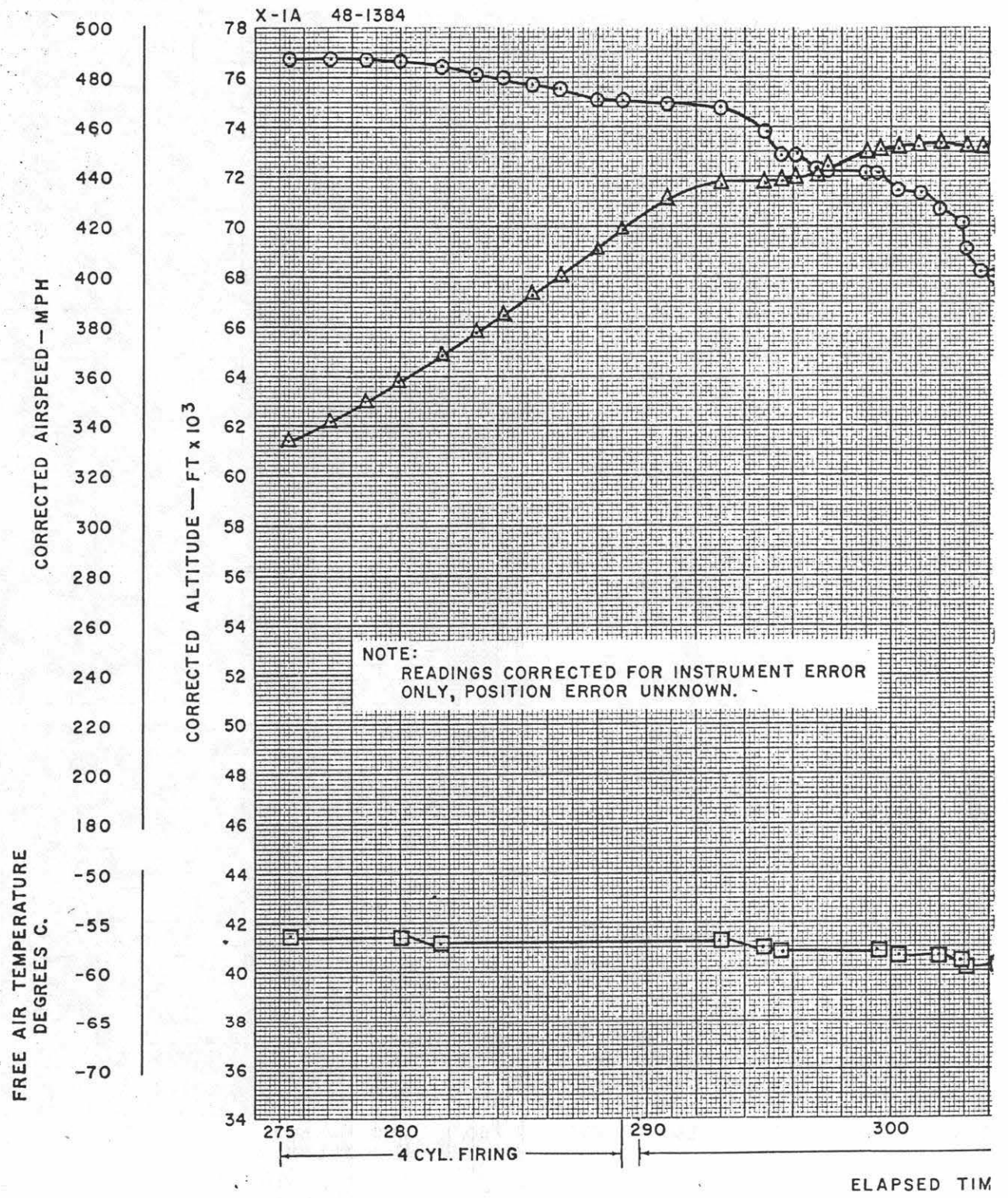

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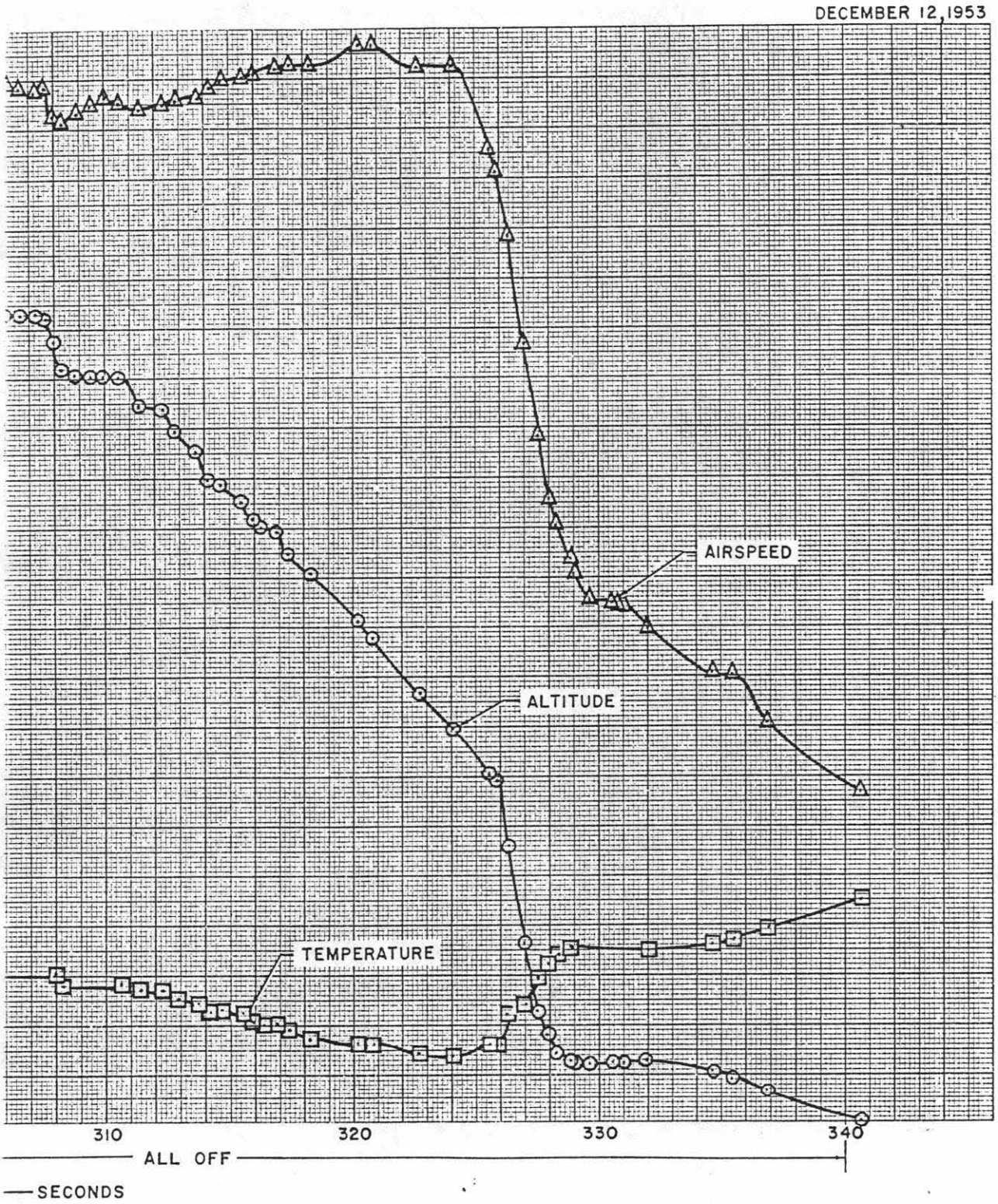

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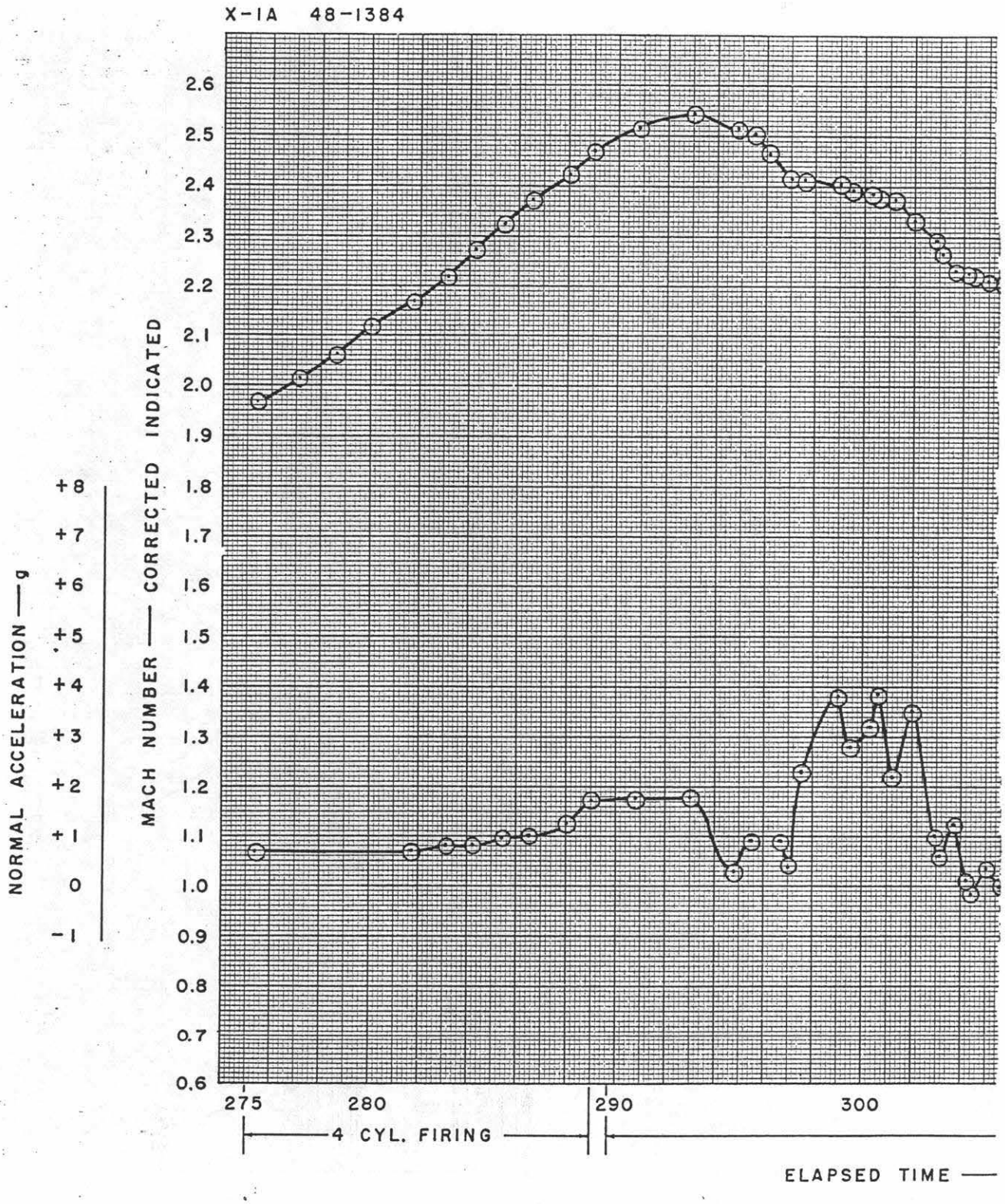

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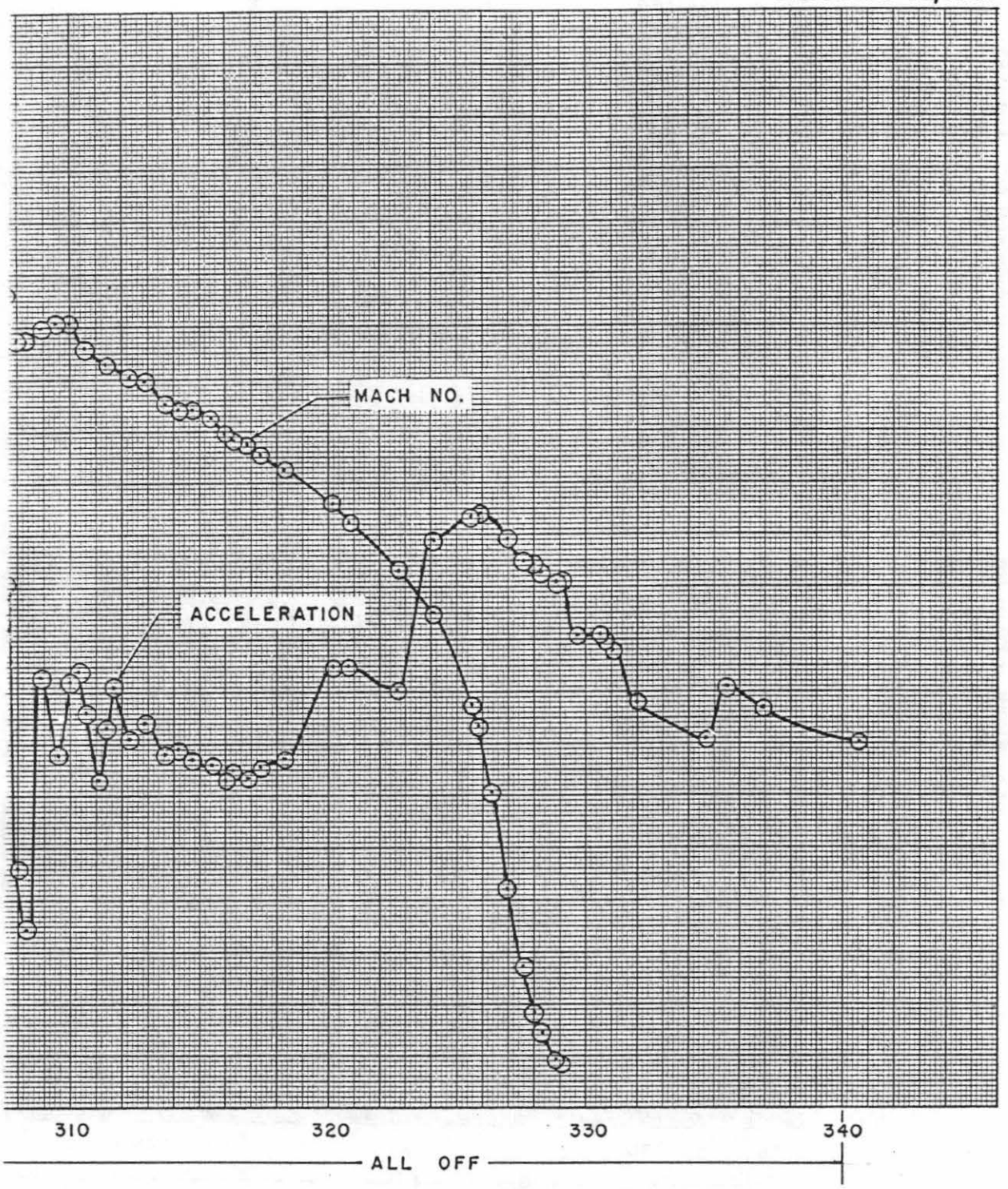

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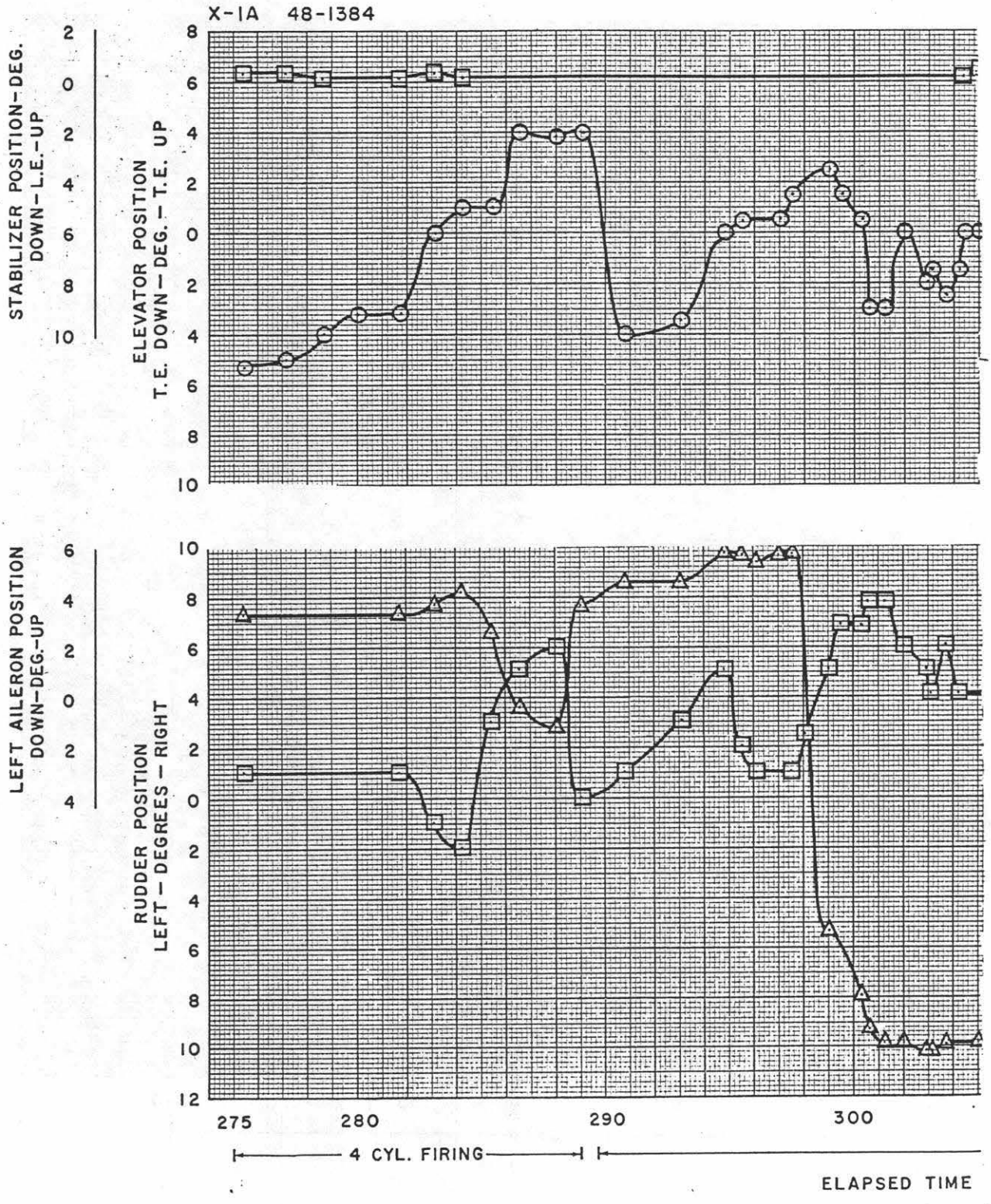

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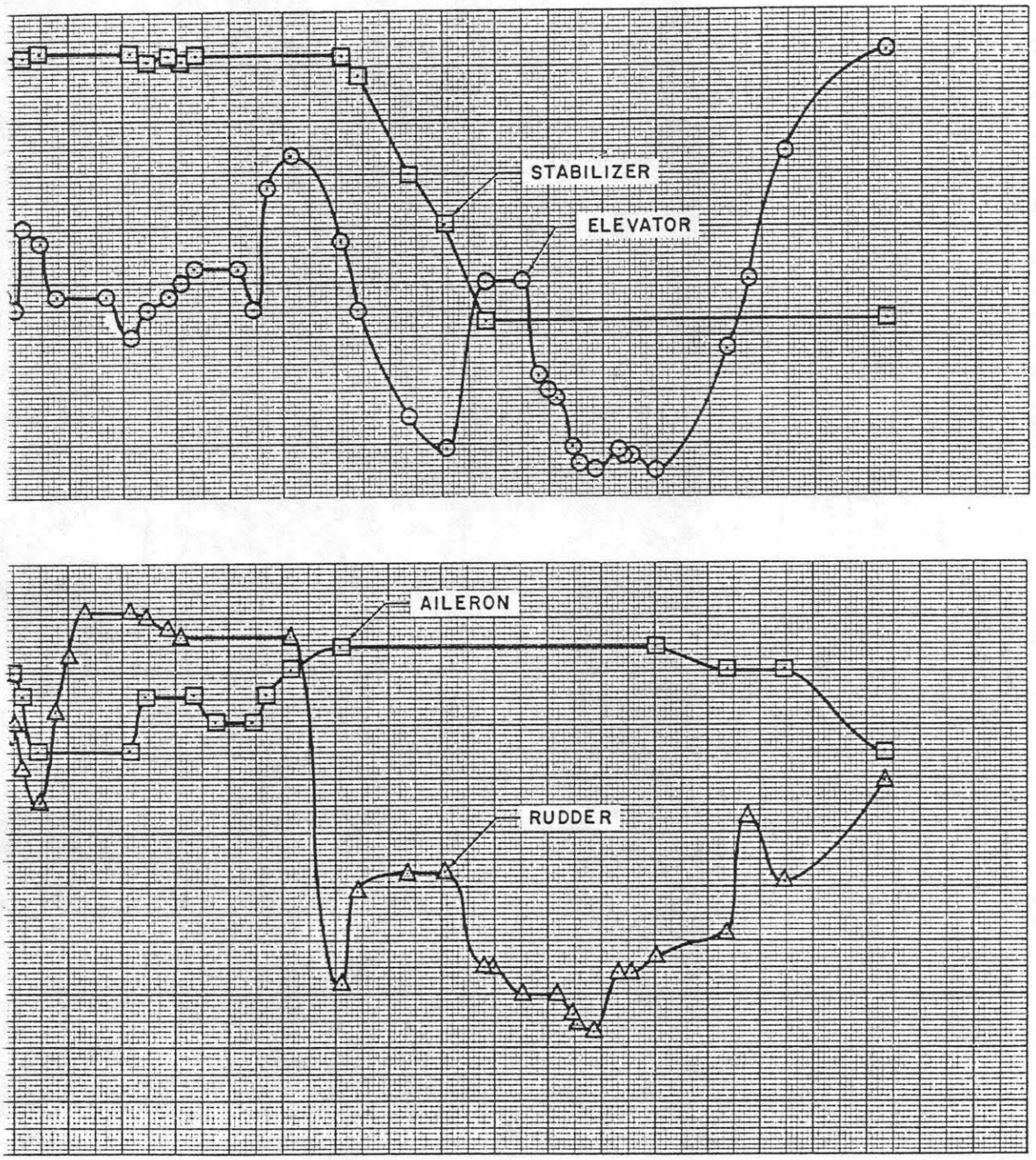

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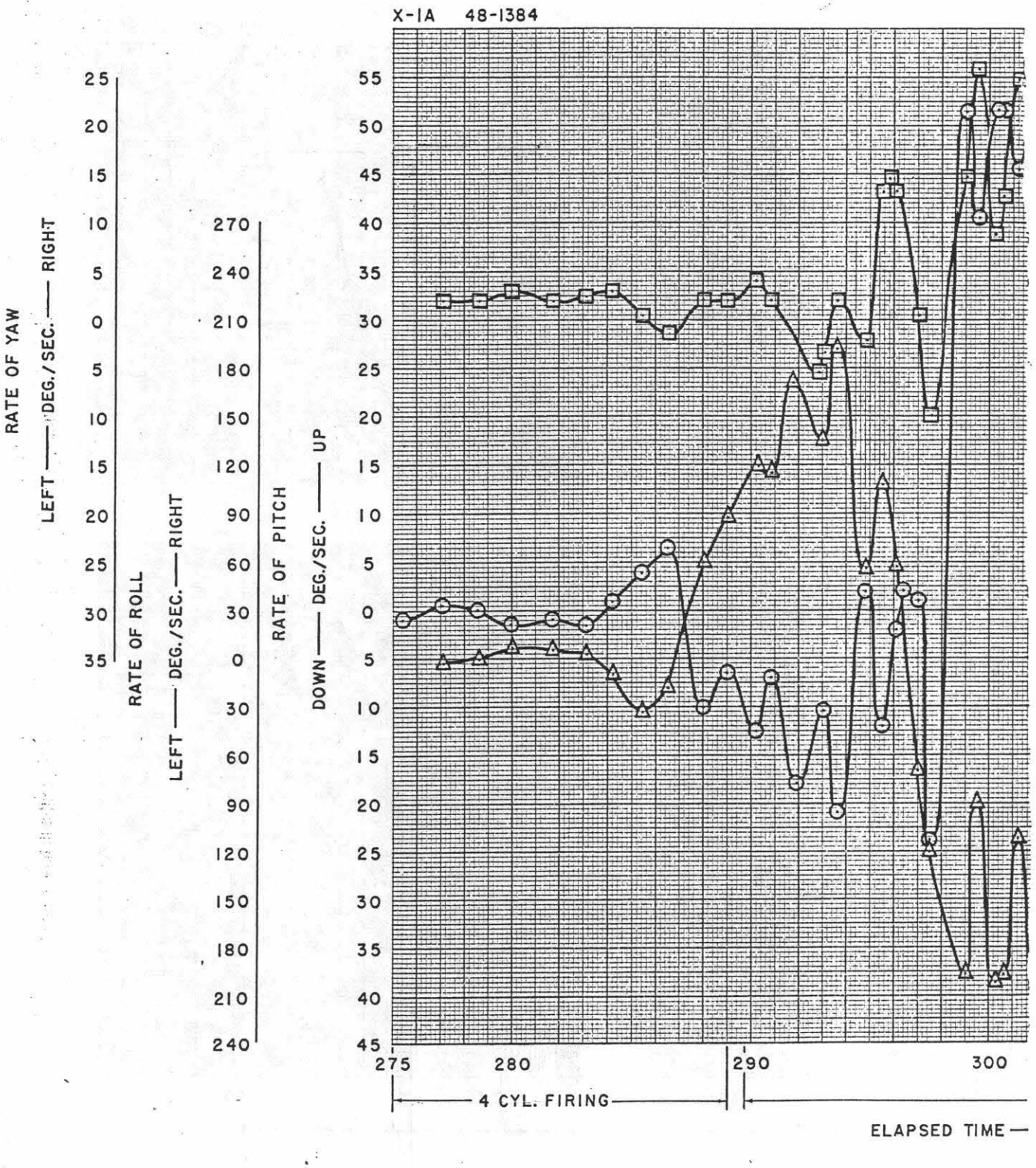

Figure 5g. Expanded Time Histor

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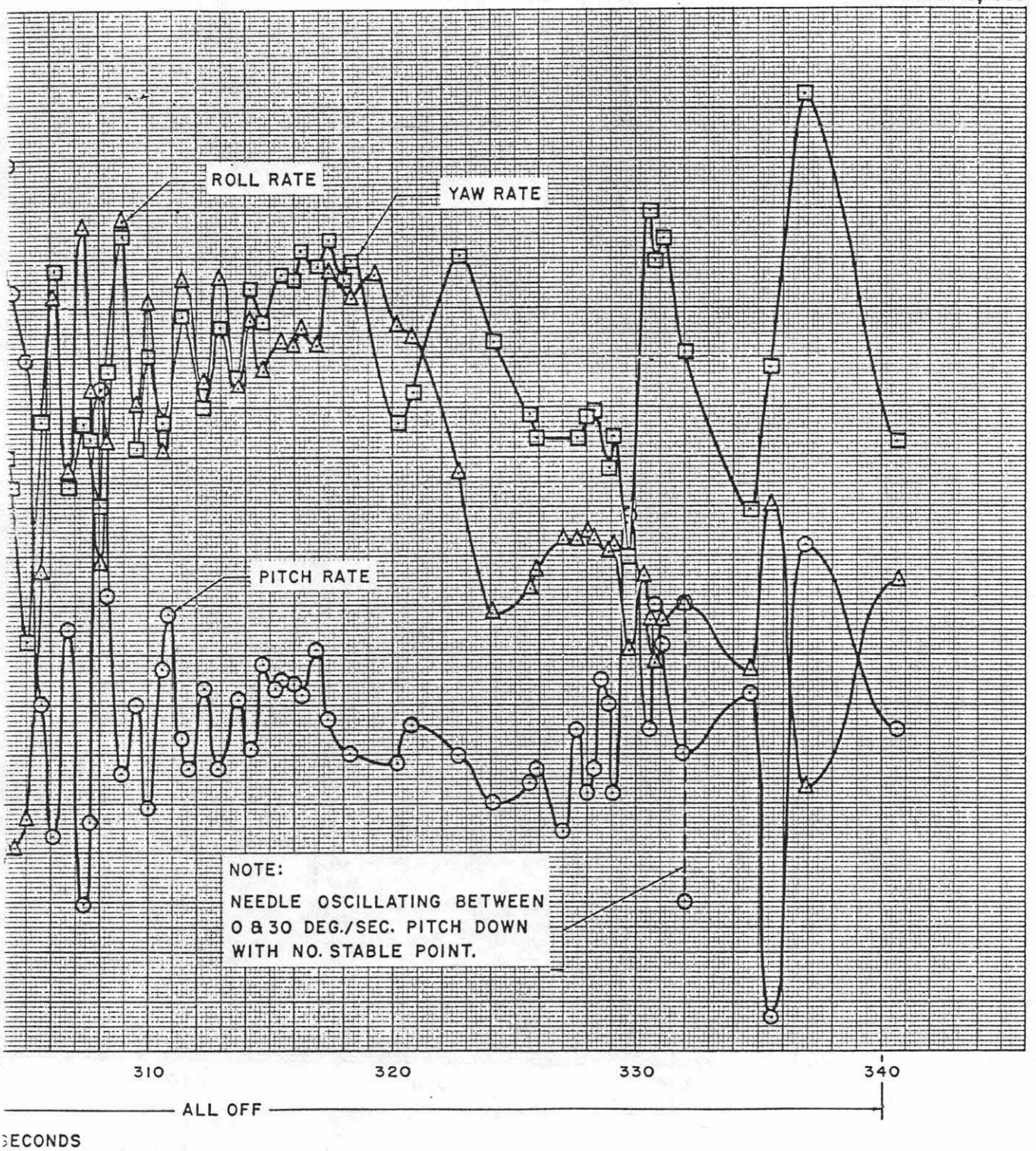

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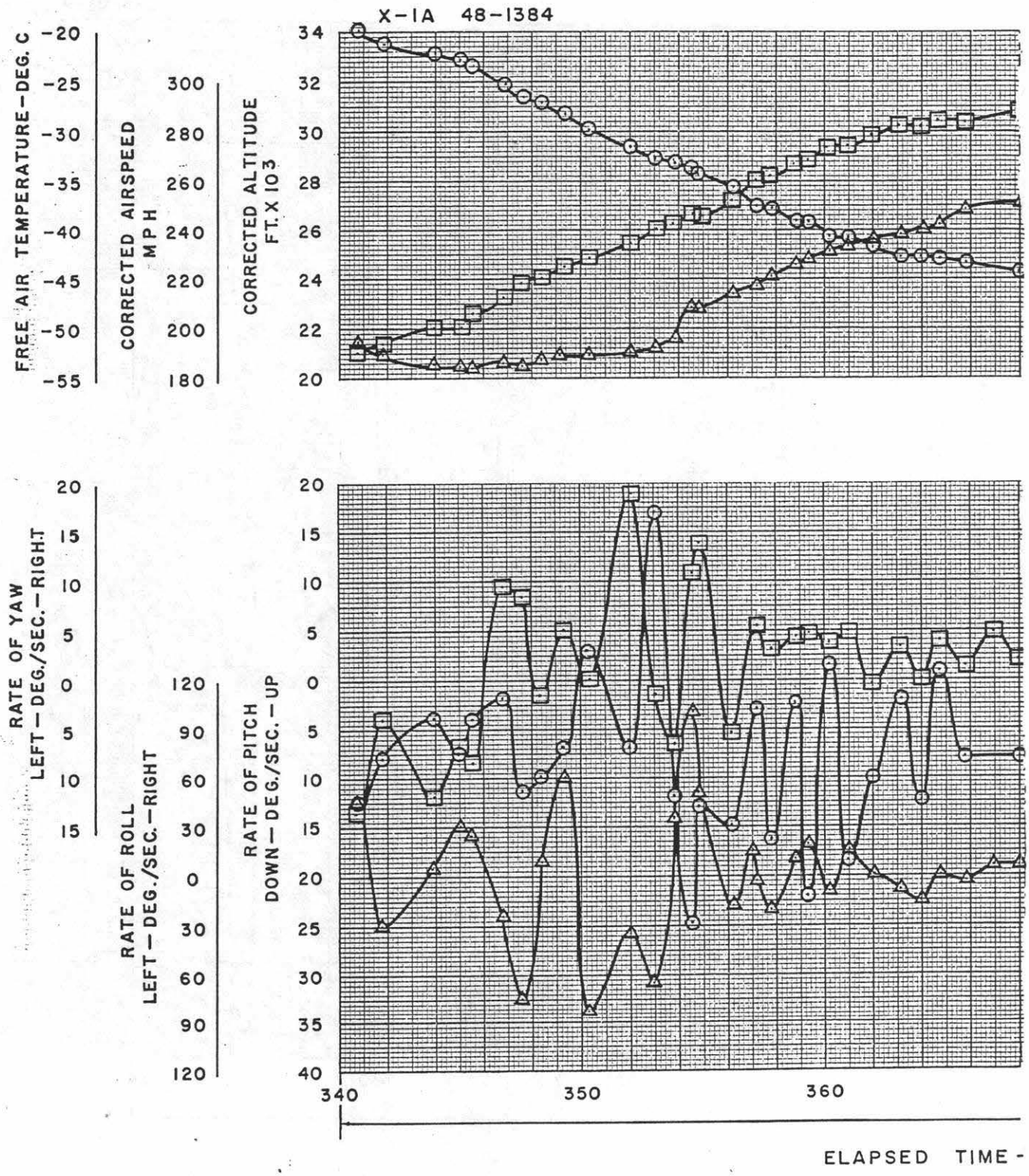

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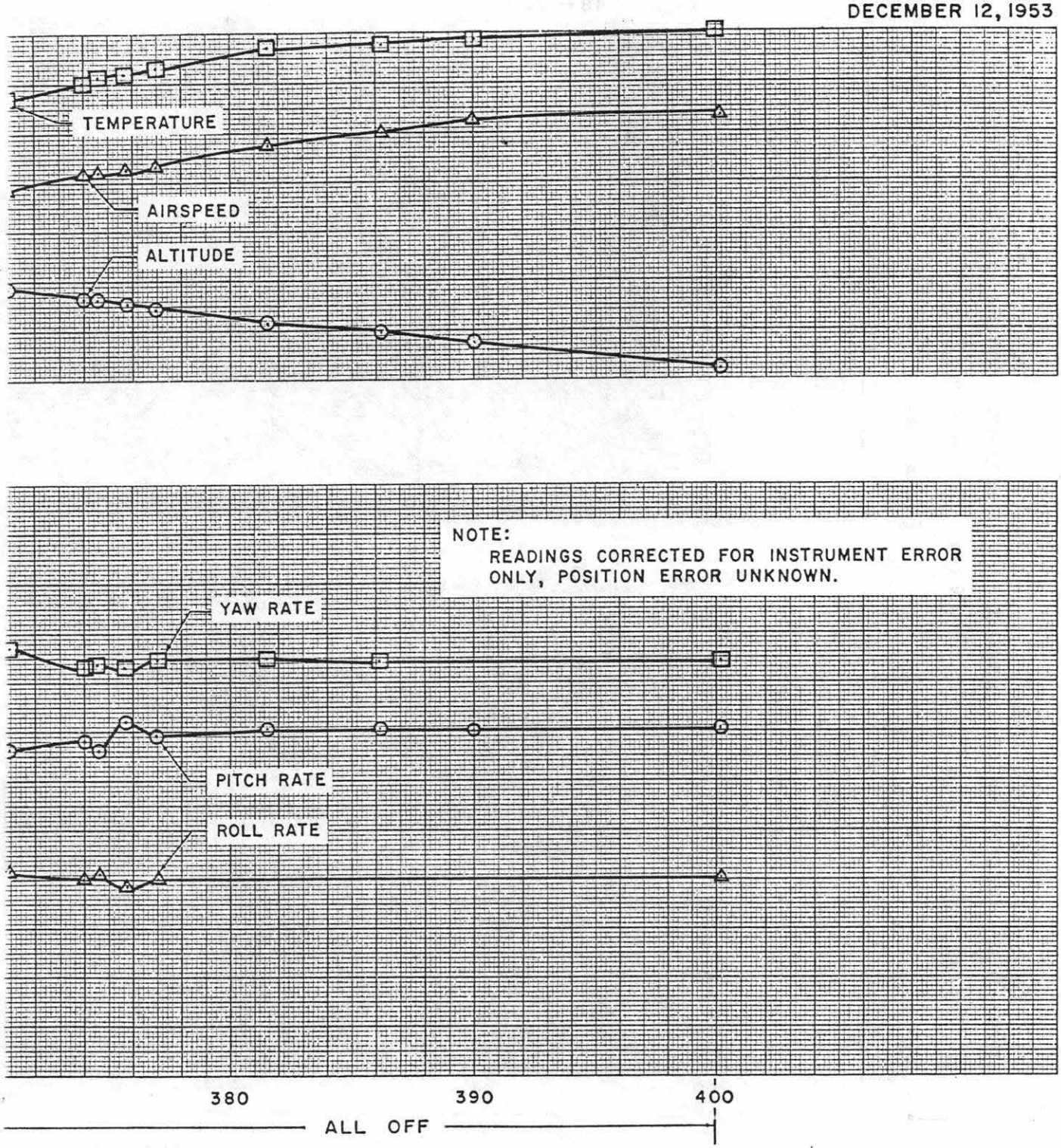

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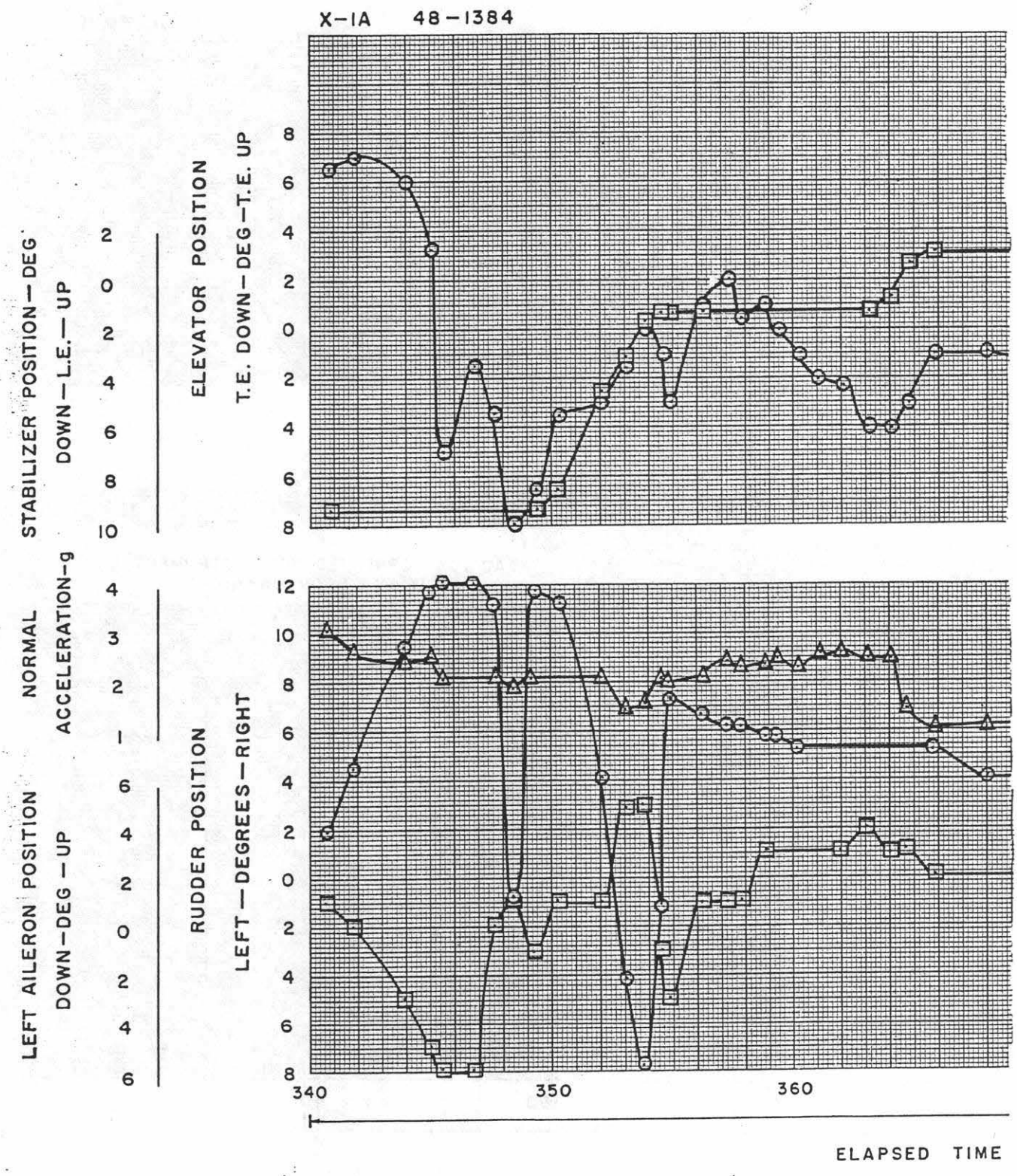
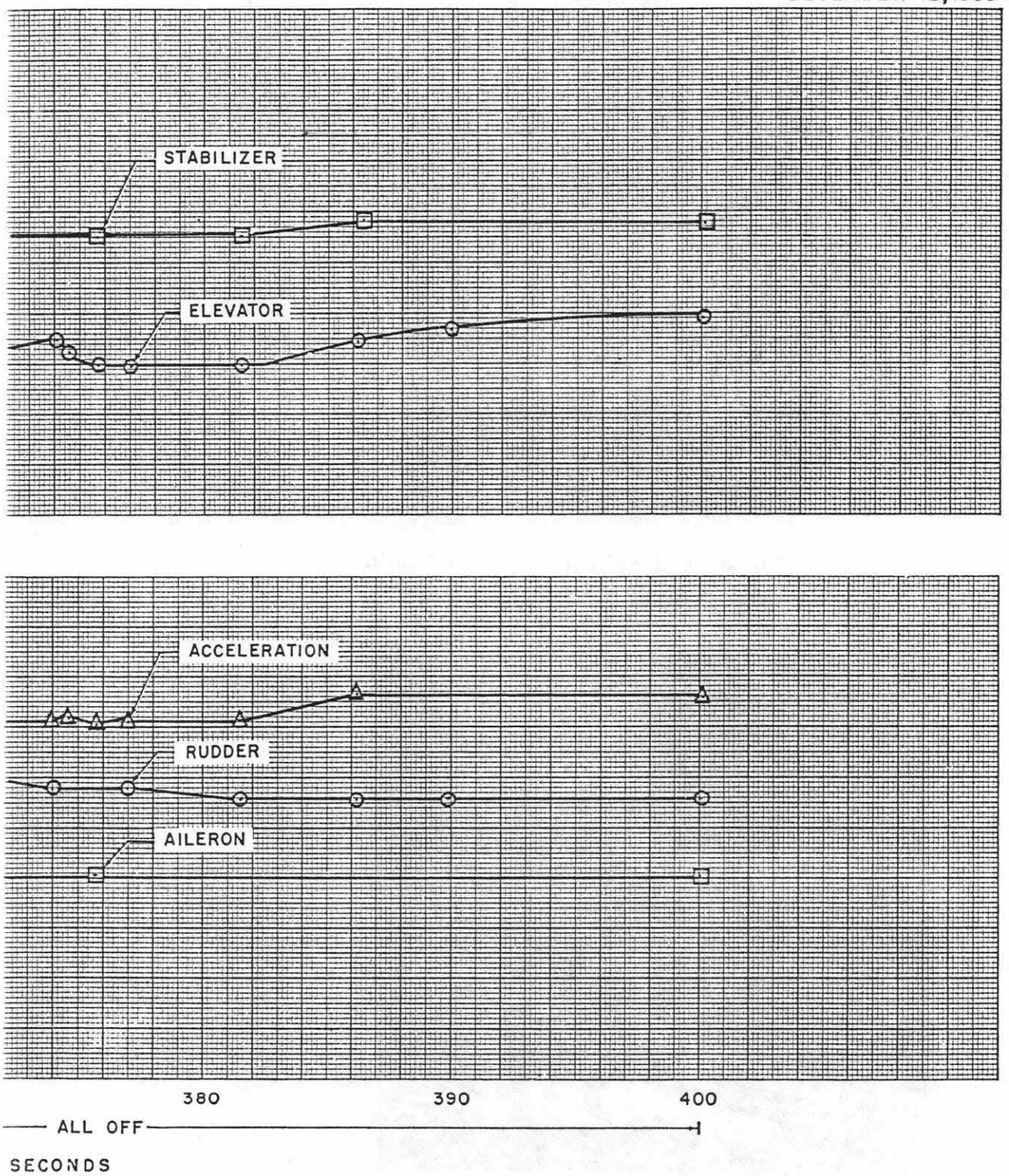


Figure 5i. Expanded Time Histor

DECEMBER 12, 1953



Flight Path for Flight No. 10

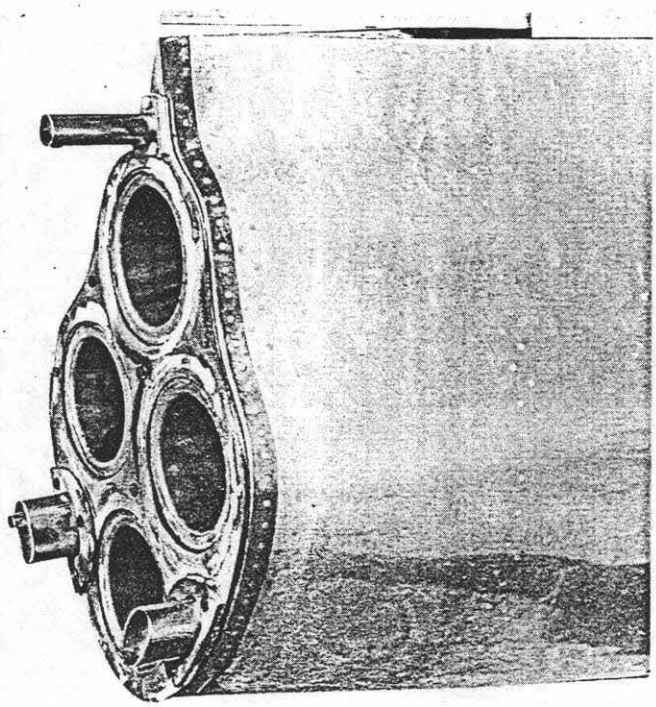


Figure 6. Copper and Asbestos Flame Shield Around Thrust Chambers After Flight

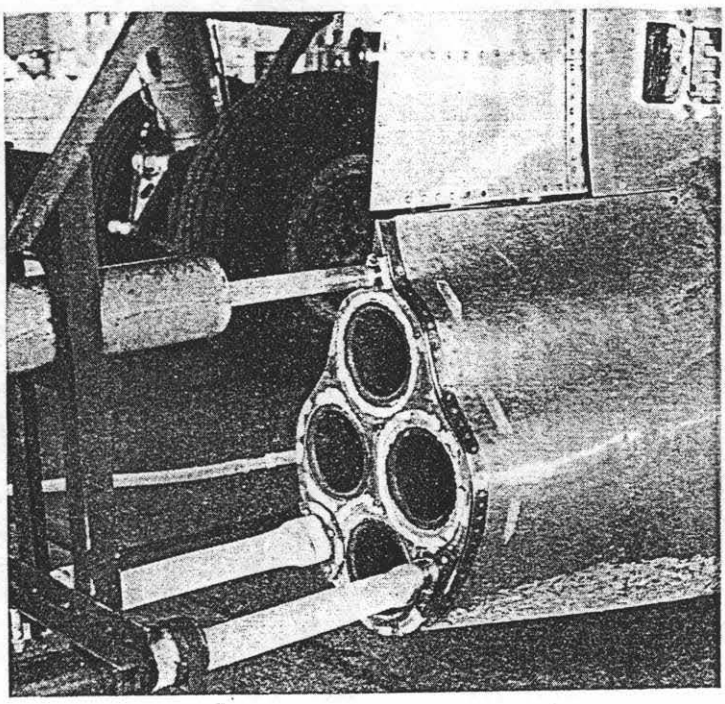


Figure 7. Copper and Asbestos Flame Shield Around Thrust Chambers Before Flight

V Discussion

The rocket engine performance was entirely satisfactory throughout the flight. A change was incorporated on the inflight check list to prevent excess loss of liquid oxygen from the X-1A immediately prior to launch. This change was to check lox jettison prior to securing lox top-off procedure. Previously jettison was checked after the top-off was completed. This procedure was very satisfactory since the pilot reported that the launch on this flight was the best he had experienced. This new procedure will be used on all subsequent flights.

Prior to Flight No. 10, all NACA recording instrumentation was checked and calibrated by NACA personnel. Instrumentation for this flight was identical with Flight No. 9 with the exception of A-3 Machmeters in the pilot's panel and the photo panel replacing the A-2 Machmeters.

The rocket engine was thoroughly preflight inspected and given an igniter check by R.M.I. personnel. The igniter check being entirely satisfactory, a ground run was not performed prior to Flight No. 10.

The X-1A Airplane was launched with no delay on drop signal at 31,000 feet. The thrust chambers were ignited in the sequence planned as shown in Figure 8, and the flight plan was flown with a high degree of accuracy. The rocket engine was shut down by the pilot prior to propellant exhaustion. Estimates on four-cylinder burning time remaining at shutdown vary from five seconds to 15 seconds. This information discloses that higher speeds are attainable with the X-1A Airplane in its present configuration.

The elevator retained its control effectiveness throughout the flight. The stabilizer position was not changed until the unstable region was entered after rocket engine shutdown.

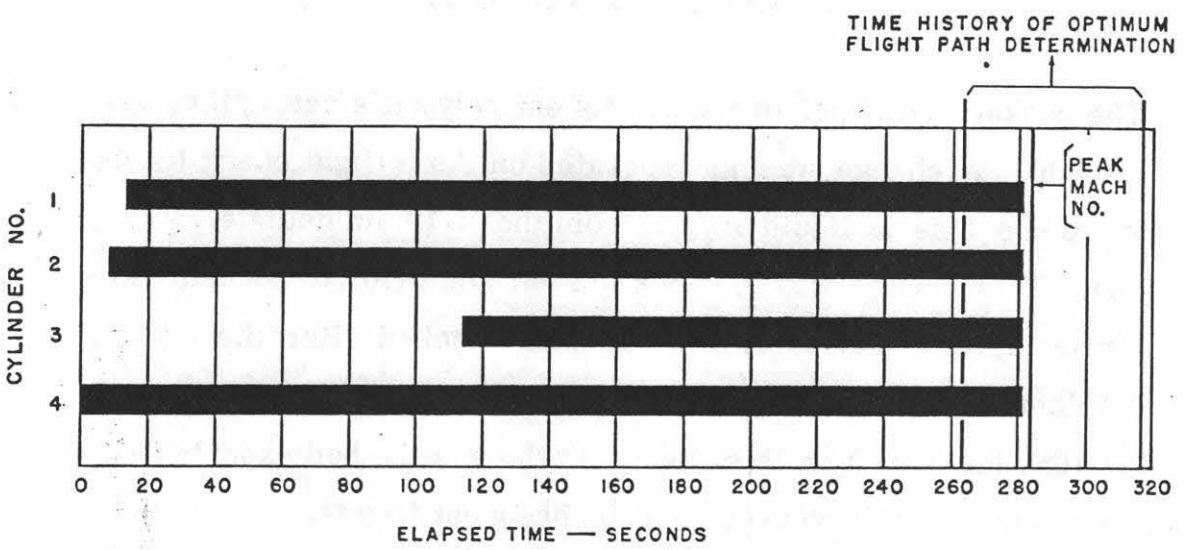


Figure 8. Cylinder Firing Sequence for Flight No. 10

The cockpit canopy was cracked by the pilot's helmet during the violent maneuvers encountered after rocket engine shutdown (Figure 9). The pilot reported that he had not used the shoulder harness during this flight.

Rough data from the NACA recording accelerometer disclosed that plus 8.15g and minus 1.0g normal acceleration were encountered in the unstable region. Lateral acceleration of 1.6g occurred at this time. The longitudinal acceleration reading at the start of four-cylinder operation was plus 0.6g decaying to plus 0.4g just prior to rocket engine shutdown. Immediately after rocket engine shutdown the longitudinal acceleration reading was minus 0.56g.

A thorough postflight inspection revealed no damage had been incurred by the X-1A Airplane during these violent maneuvers. Flight controls were inspected and found well within "free" play tolerances. No buckling or canning was found on the external surface of the aircraft.

An impromptu heat survey was conducted during this flight by utilizing Tempilac paint on nose ogive (Figure 10), right wing (Fig-

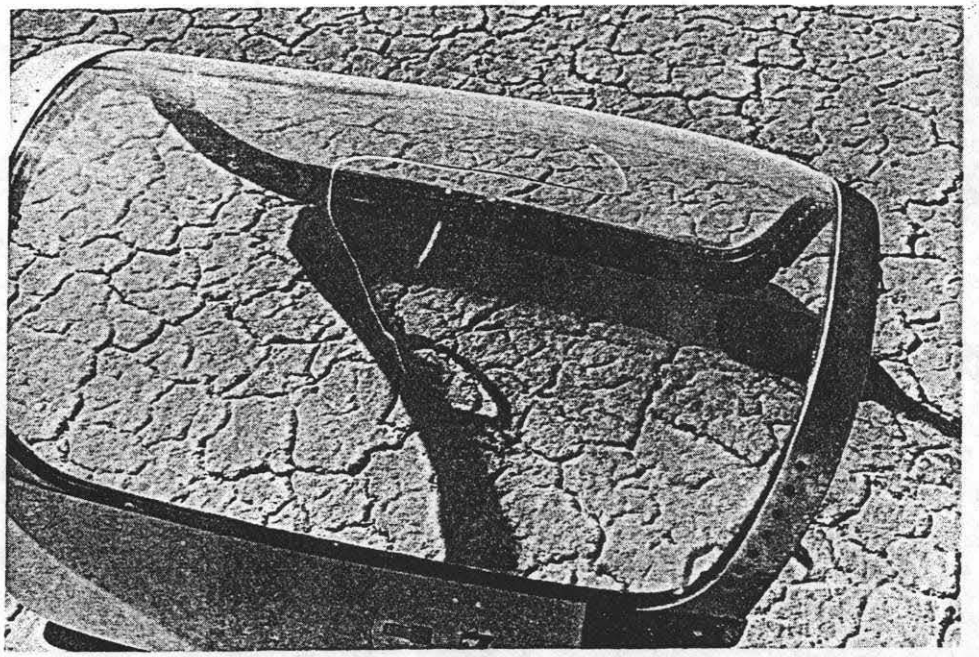


Figure 9. Cracked Cockpit Inner Canopy

ure 11), left wing (Figure 12), and on left side of rudder (Figure 13). The appearance of these painted sites after the flight is also illustrated in Figures 14, 15, 16, 17, 18, and 19. Highest temperature rise shown by the Tempilac was 163°F paint plus ambient of minus 70°F (approximately) or 233°F rise. Temperature rise on various parts of the airplane structure can definitely be checked by the use of Tempilac paints. Various skips shown by discontinuity of Tempilac indication of heat are thought to be caused primarily by internal structure under the skin causing local heat gradients (Figure 20). 175° Tempilac on leading edge of windshield displayed no change during the flight.

Figures 5a, 5c, and 5f disclose increasing right rudder position throughout the powered portion of the flight. Consultation with the pilot reveals that the left wing picks up heaviness with increase of Mach number.

Due to the pilot's inability at this time to reach the aileron trim control, the rudder was used for lateral trim.

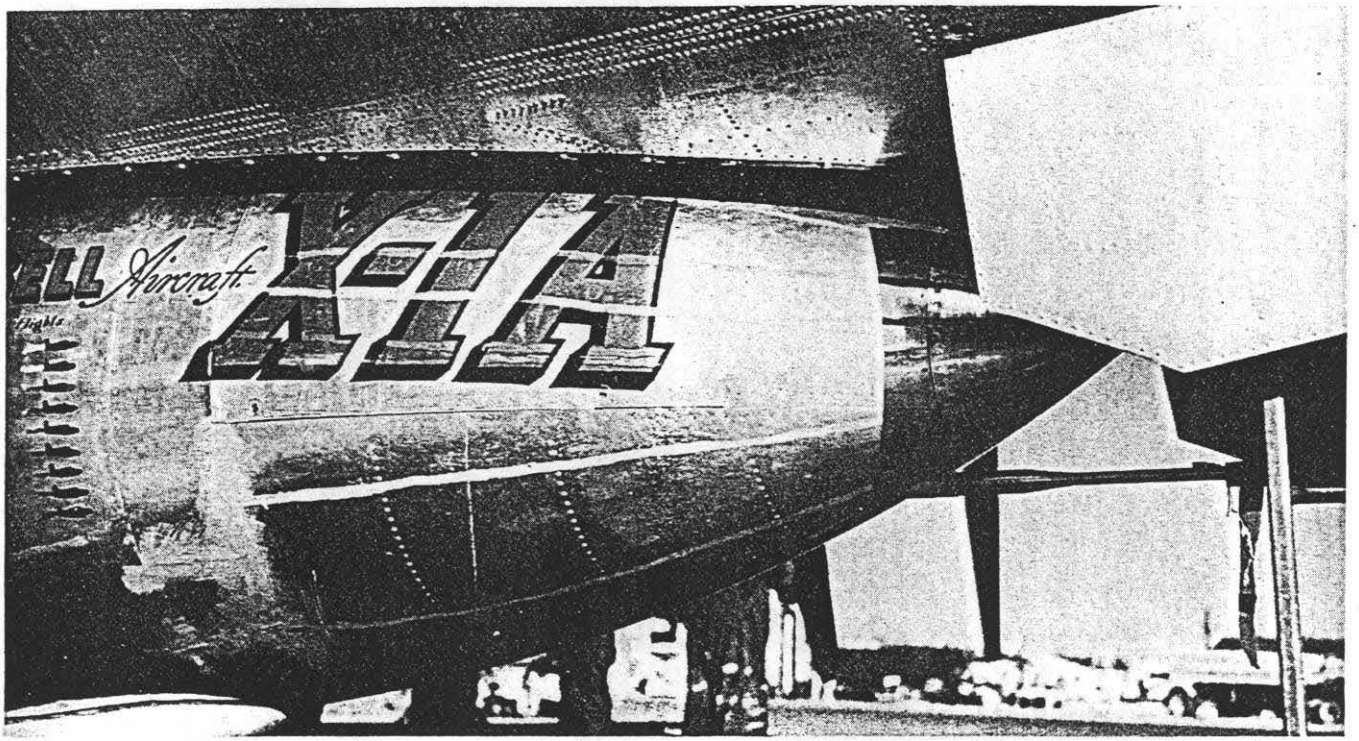


Figure 10. Tempilac Paint on Nose Ogive Prior to Flight

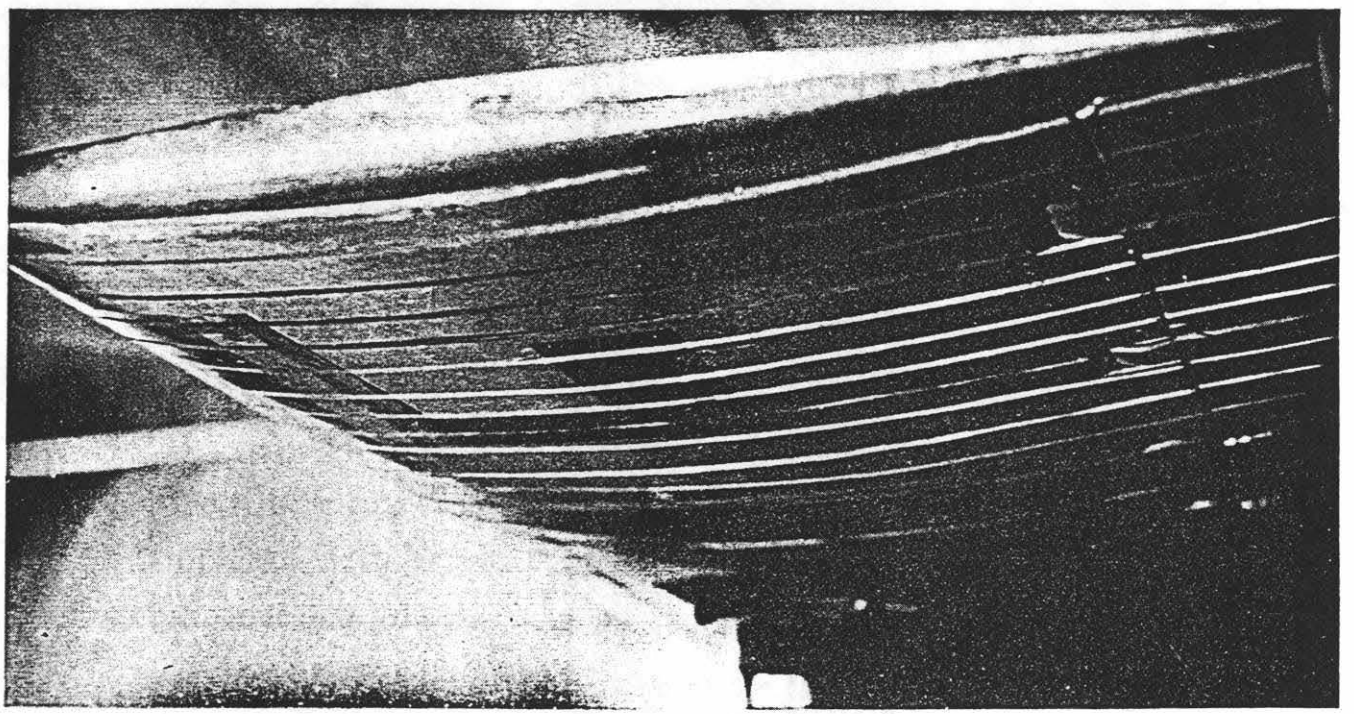


Figure 11. Tempilac Paint on Underside of Left Wing Prior to Flight

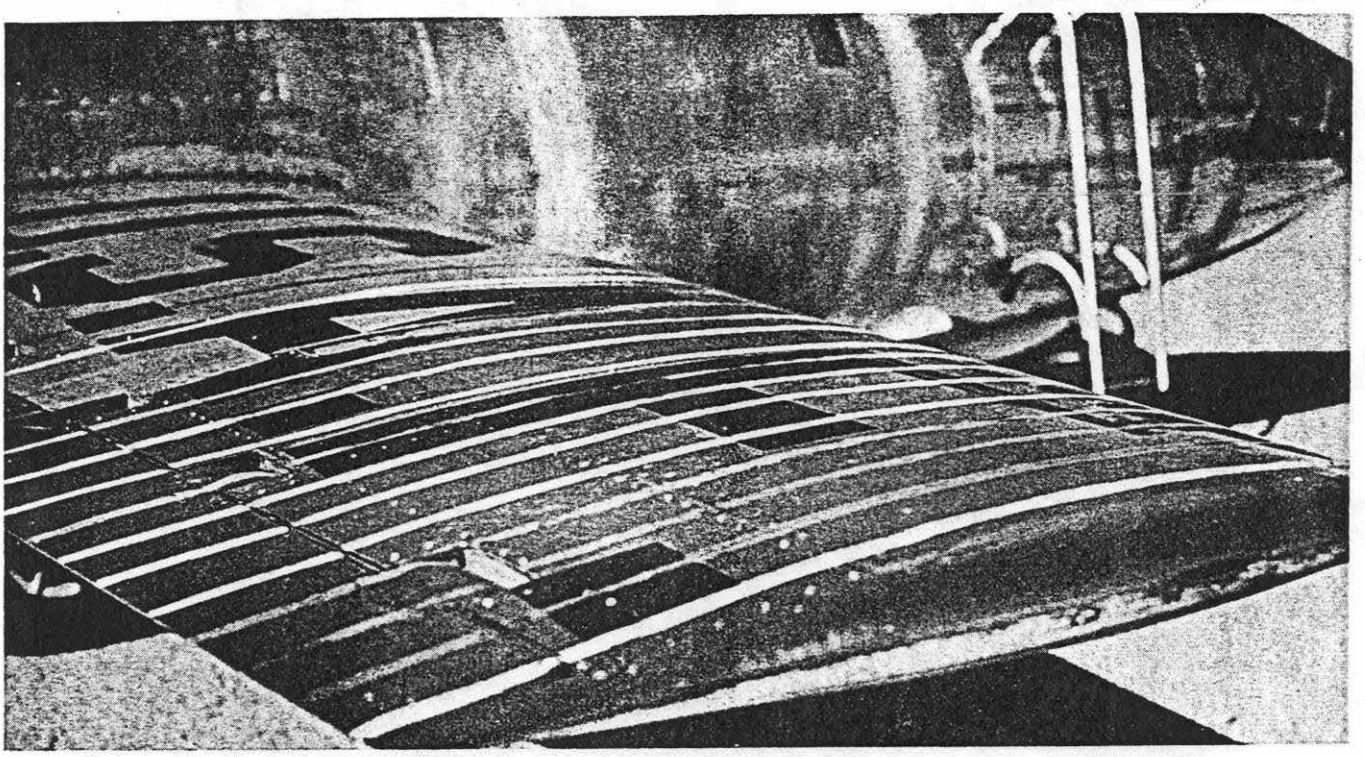


Figure 12. Tempilac Paint on Right Wing After Flight

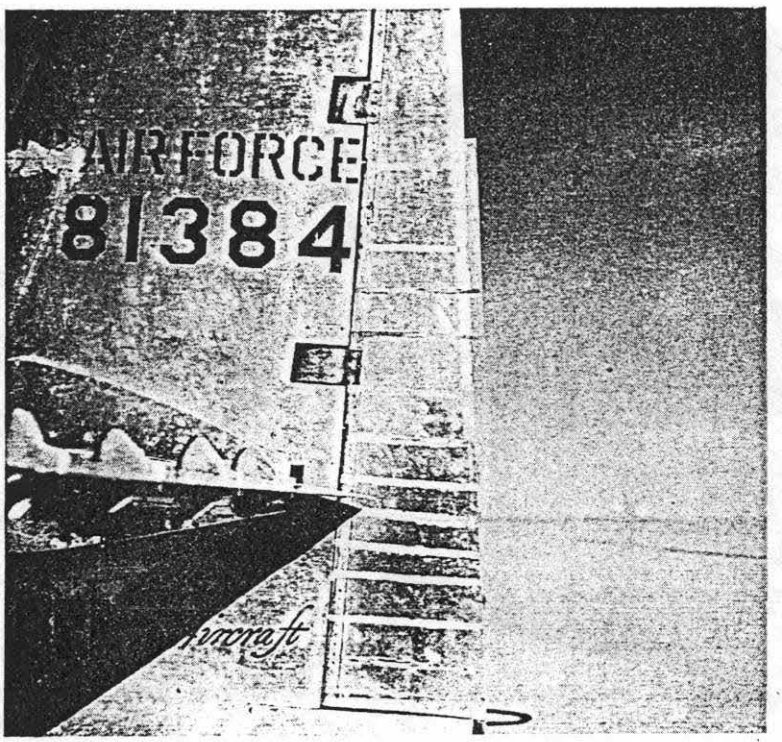


Figure 13. Tempilac Paint on Rudder After Flight

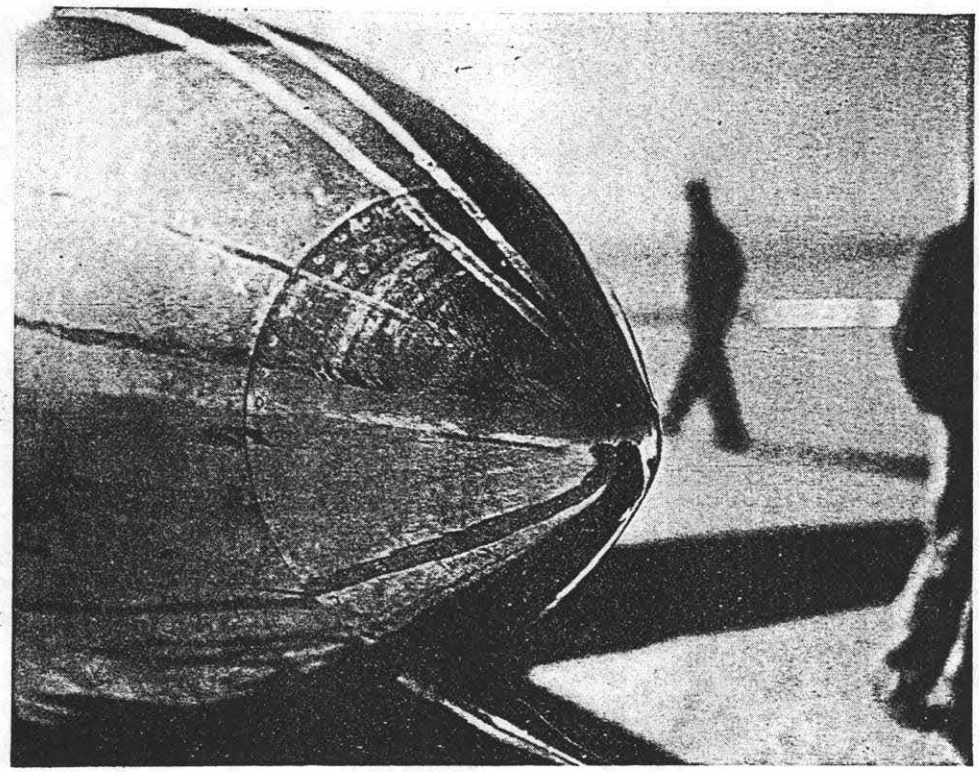


Figure 14. Tempilac Paint on Nose Ogive After Flight

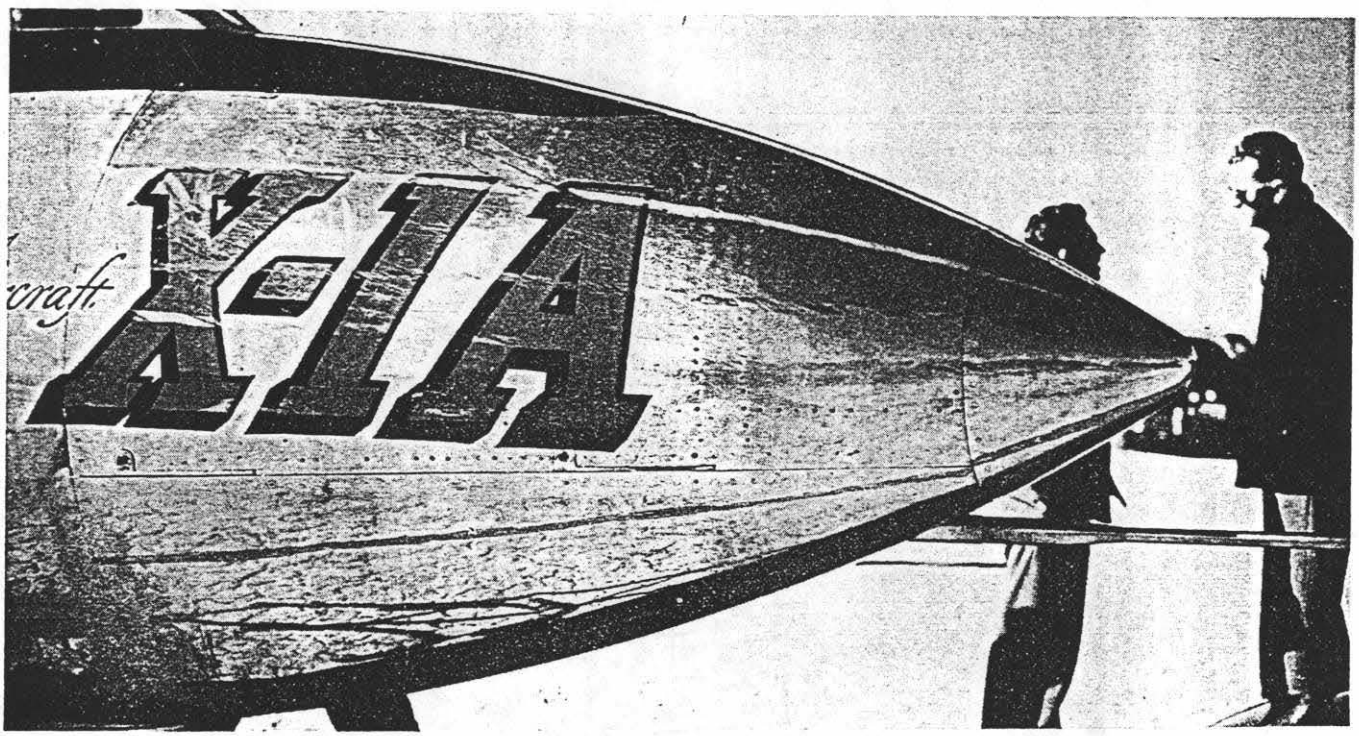


Figure 15. Side View of Tempilac Paint on Nose Ogive After Flight

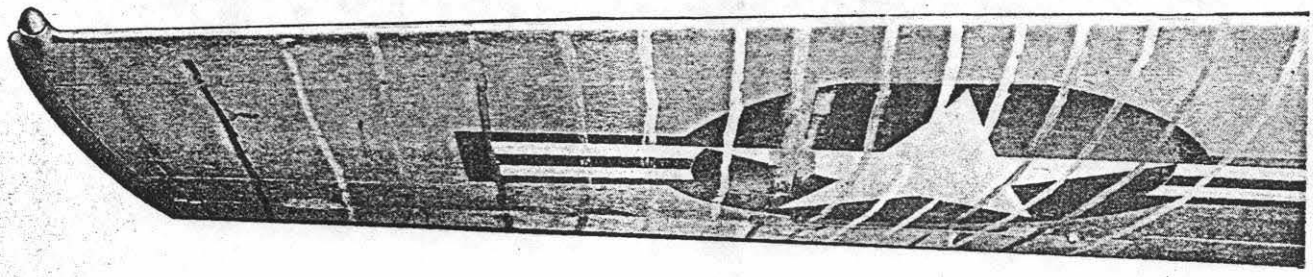


Figure 16. Tempilac Paint on Underside of Right Wing After Flight

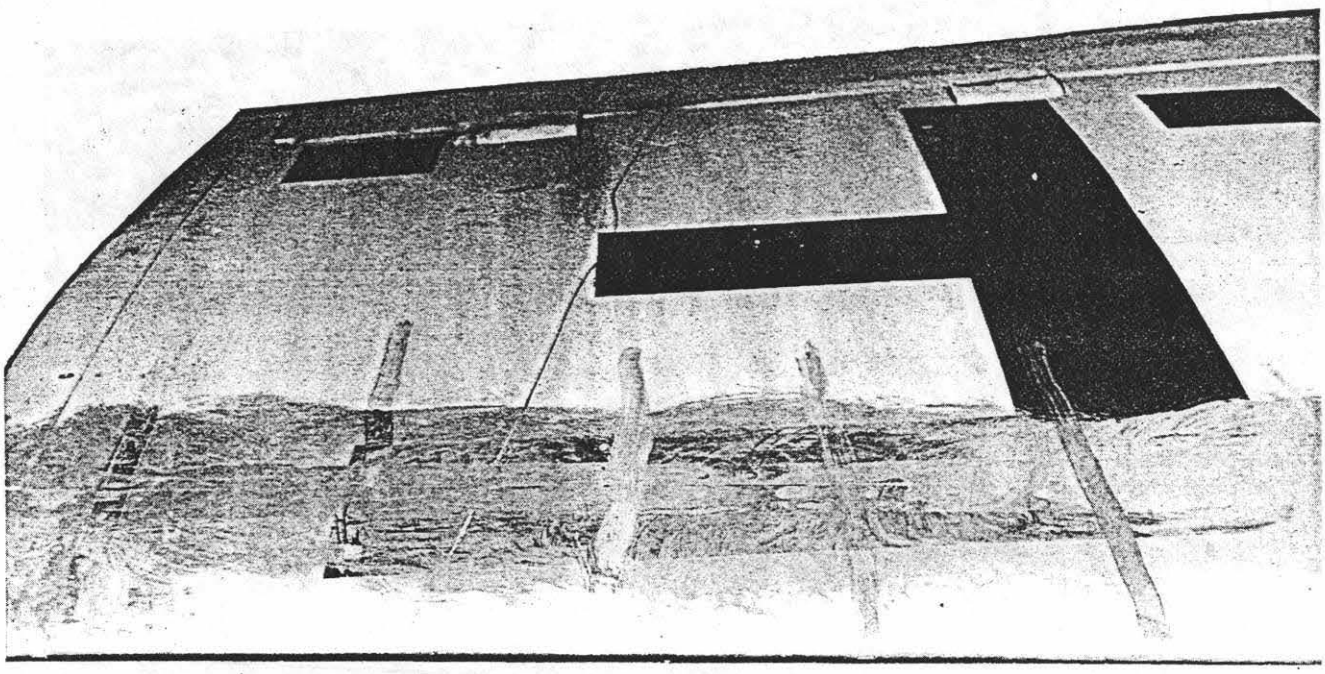


Figure 17. Tempilac Paint on Upper Side of Right Wing After Flight

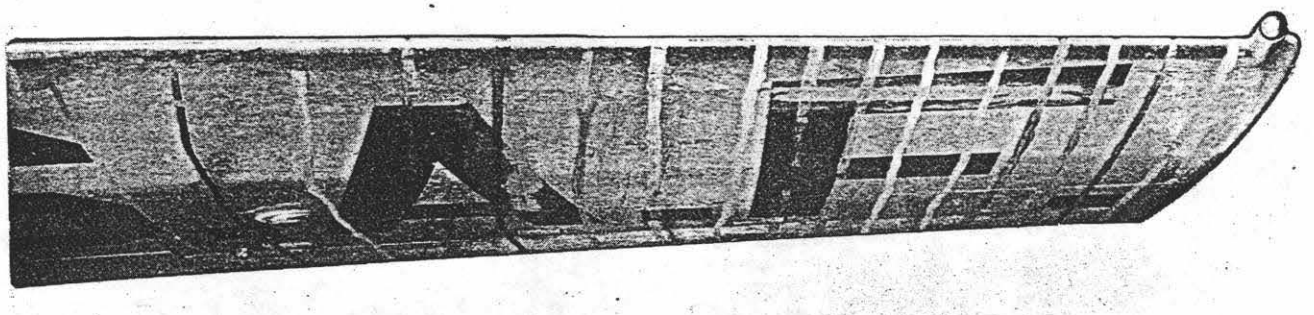


Figure 18. Tempilac Paint on Underside of Left Wing After Flight

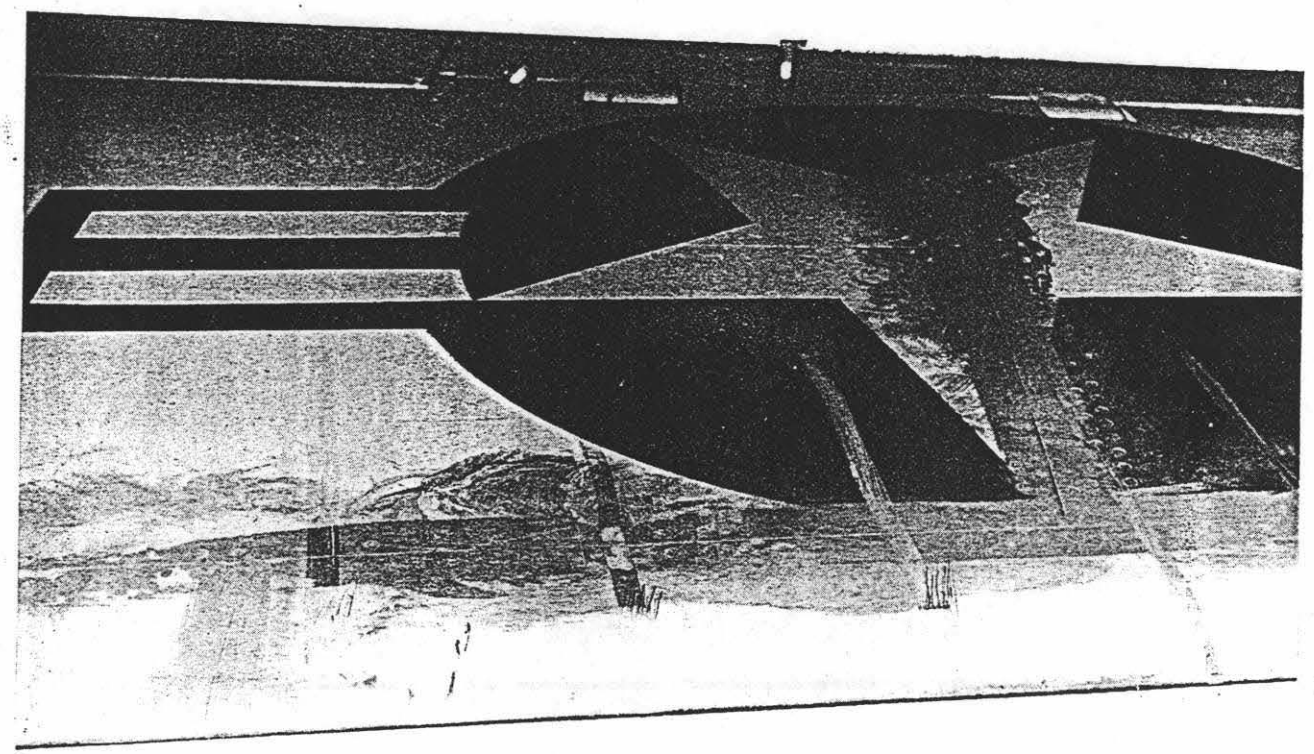


Figure 19. Tempilac Paint on Upper Side of Left Wing After Flight

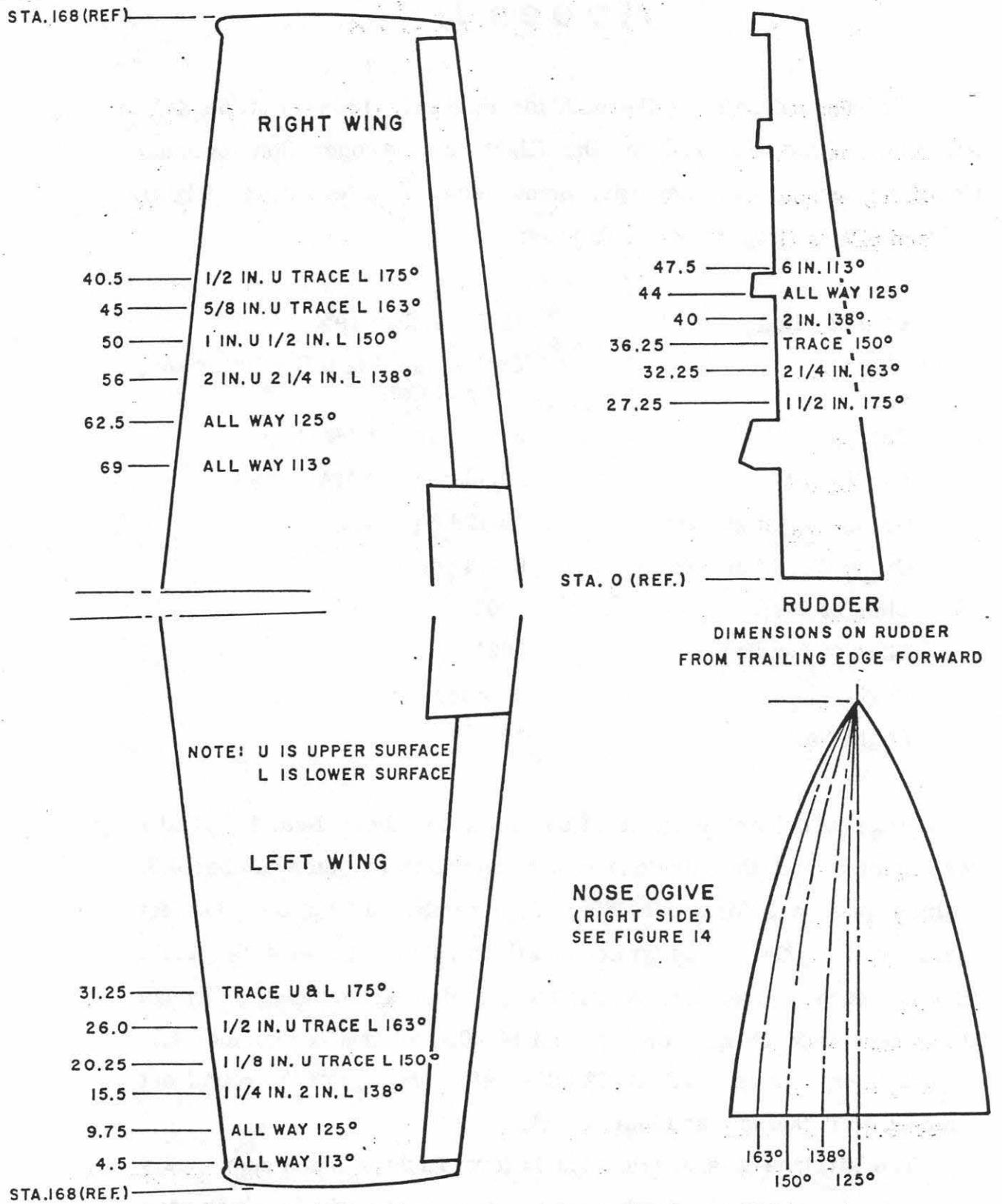


Figure 20. Tempilac Paint Effects After Flight

VI Appendix

Presented herein are the data for Flight No. 1384-10 of the X-1A Airplane. Time Histories of the flight, engine operation (cylinder firing sequence), heat sensitive paint (tempilac effects after flight), and pilot's flight report are as follows:

Date of Flight	12 December 1953
Weather	Ceiling and Visibility Unlimited, Winds Calm
Drop cg	22.56 percent MAC
Landing cg	22.73 percent MAC
Gross Weight at Drop	16,198.6 pounds
Gross Weight at Landing	6,978 pounds
Time of Drop	1007
Time of Landing	1021
Flight Time	14 minutes
Flight No.	10

After a normal drop at 31,000 feet, chambers Nos. 4, 2, and 1 were ignited and the airplane was accelerated to Mach number 0.8. A flight path was formed holding Mach number 0.8 up to 43,000 feet where chamber No. 3 was ignited and the airplane accelerated in level flight to Mach number 1.1. A climb was again started passing through 50,000 feet at Mach number 1.1, and 60,000 feet at Mach number 1.2. A push-over was started at 62,000 feet. The top of the round-out occurred at 76,000 feet and Mach number 1.9.

The airplane was accelerated in level flight to Mach number 2.4 when all of the rocket chambers were cut. The flight path was very

normal and nothing eventful happened up to this point. After the engine was cut, the airplane went into a Dutch roll for approximately two oscillations and then started rolling to the right at a very rapid rate of roll. Full aileron and opposite rudder were applied with no effect on the rate of roll of the airplane. After approximately 8 to 10 complete rolls, the airplane stopped rolling in the inverted position and after approximately one-half second started rolling to the left at a rate in excess of 360 degrees per second, as estimated by the pilot. At this point the pilot was completely disoriented and was not sure what maneuvers the airplane went through following the high rates of roll. Several very high "g" loads both positive and negative and side loads were felt by the pilot.

At one point during a negative "g" load, the pilot felt the inner liner to the canopy break as the top of his pressure suit helmet came in contact with it.

The first maneuver recognized by the pilot was an inverted spin at approximately 33,000 feet. The airplane then fell off into a normal spin from which the pilot recovered at 25,000 feet. The airplane was glided back to the lake bed and a normal landing was made to the north on the north-south runway.

The airplane was dropped from the B-29 at 255 mph indicated airspeed. The cg seemed to be in the normal position because the airplane on this drop seemed to be the most stable of any the pilot has ever flown.

Approximately five seconds of fuel and lox were jettisoned after recovery from the normal spin at 25,000 feet.

Records show accelerations of plus 8g, minus 1.3g and plus 2g side force.

Notes

[redacted]

[redacted]